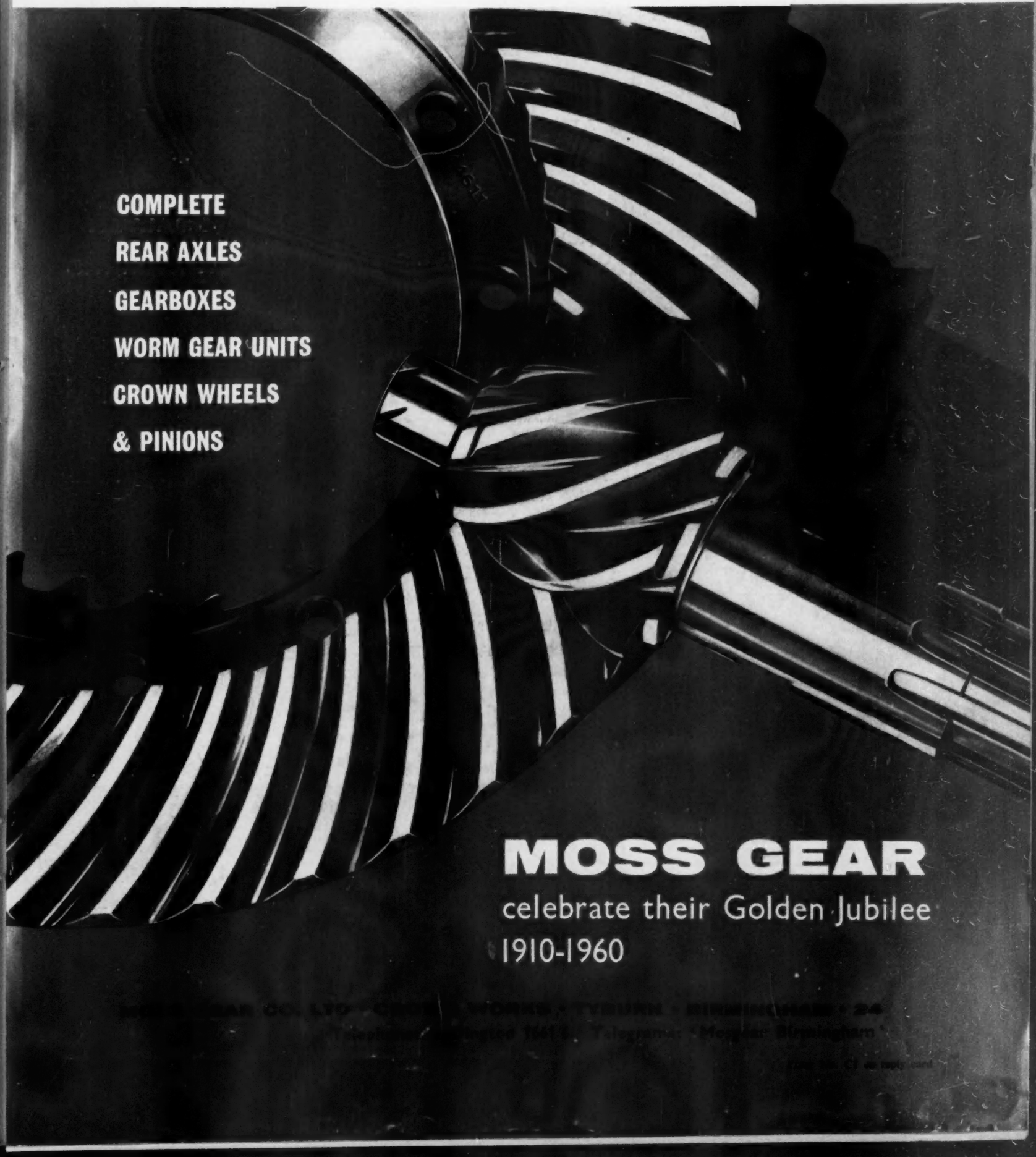
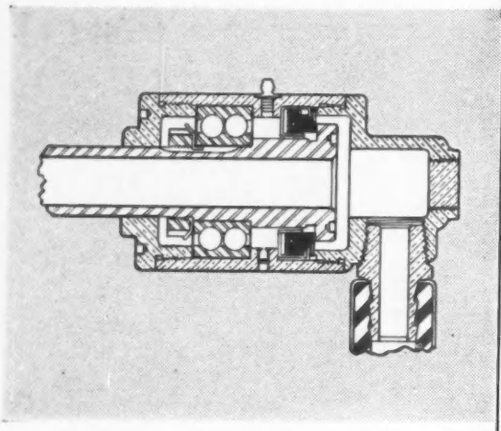
THE ENGINEER

JANUARY 22, 1960 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

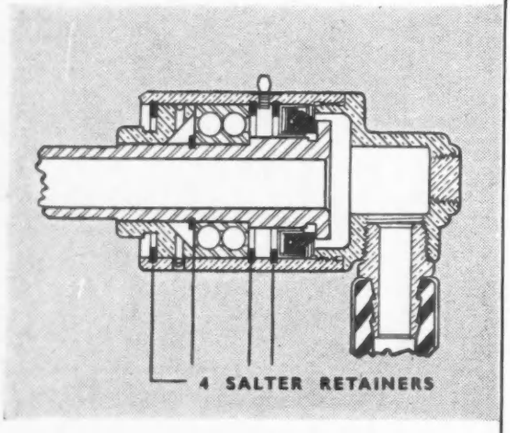


How costs are cut with SALTER RETAINERS

Salter retainers simplify design of air, water, steam union, with great savings



THE OLD WAY Air, water, steam union involved drilling, threading and milling operations. Maintenance was difficult.



THE SALTER WAY Salter retainers permit rapid, simple assembly and maintenance with a reduction in manufacturing costs.

MATERIALS SAVED	
decreased wall thickness of housing	2/9¾
eliminated bearing lock nut and washer	7¾
MACHINE OPERATIONS ELIMINATED	
bore, undercut, and tap cap end of housing	1/4¾
locate cap on arbor, and chase threads	1/-
drill spanner wrench holes	4¼
cut thread on rotor for lock nut	3¾
mill slot in thread for tang on lock washer	7½
drill spanner wrench holes in rotor	4¼
ASSEMBLY OPERATIONS ELIMINATED	
Install lock washer, tighten lock nut, bend lug	8½
assemble cap into housing	4
TOTAL SAVING WITH SALTER RETAINERS	8/6½

*

4 SALTER RETAINERS simplify design, assembly and maintenance with a saving of 8/6½ per unit

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Retainers

Fixes

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THE ENGINEER

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No. 5426 JANUARY 22, 1960 VOL. 209

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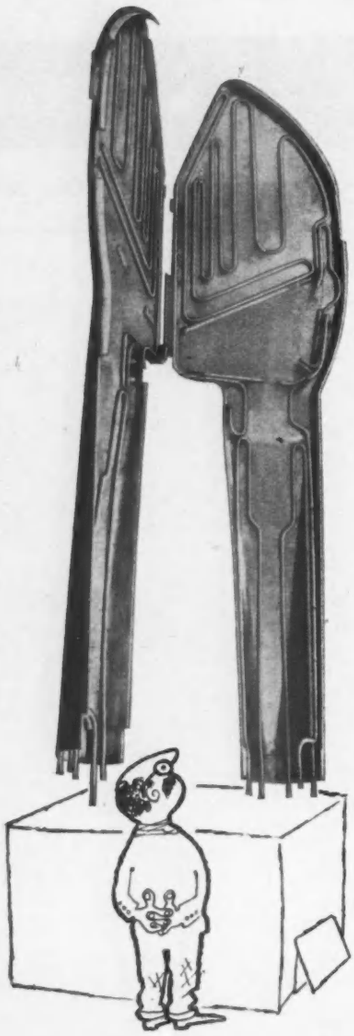

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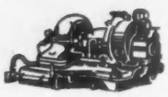

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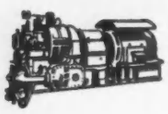

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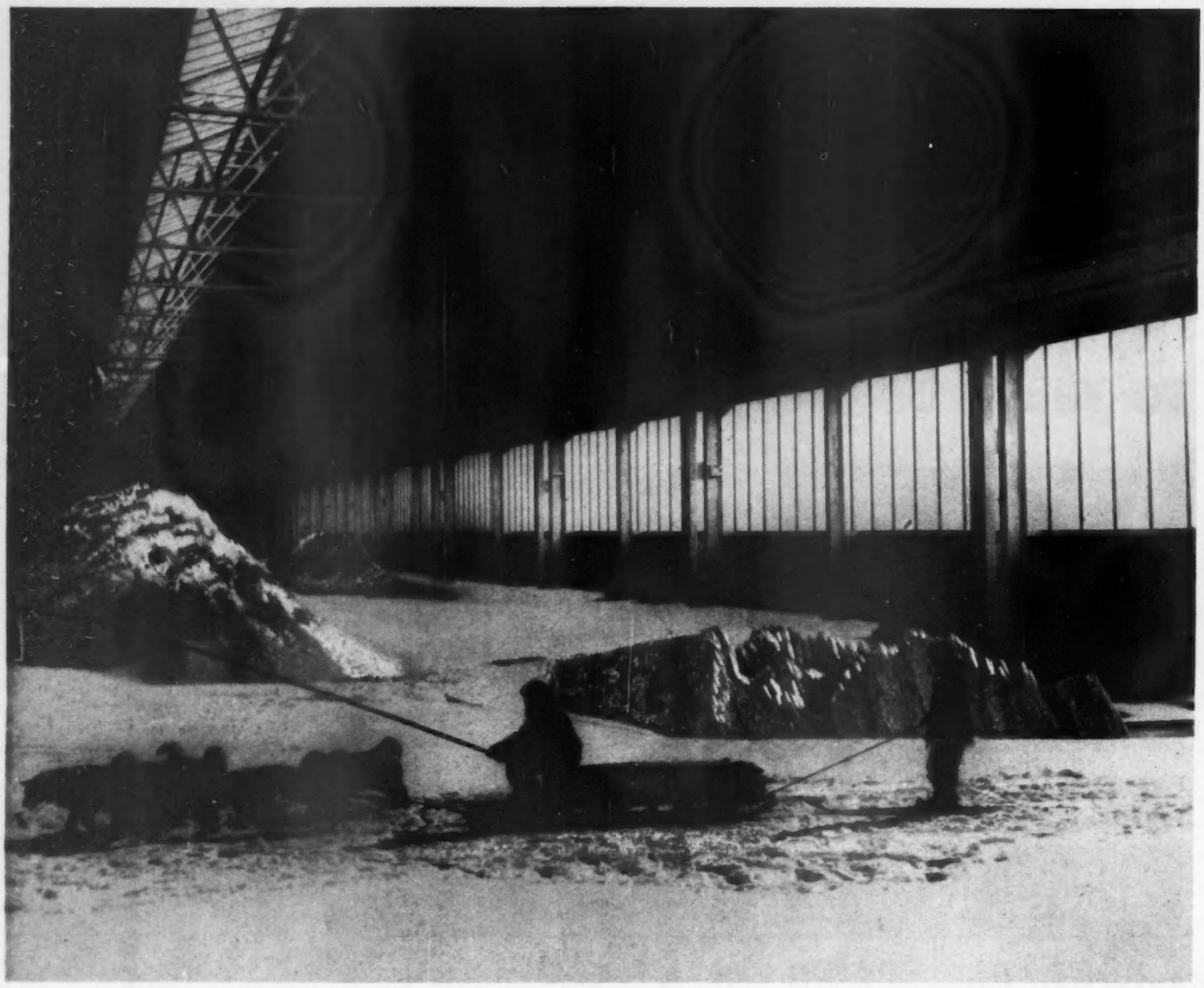

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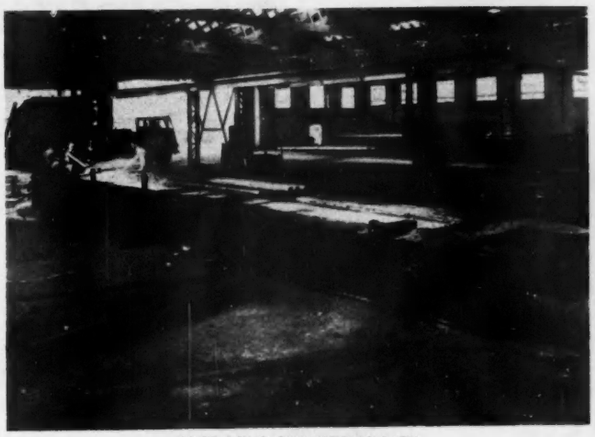

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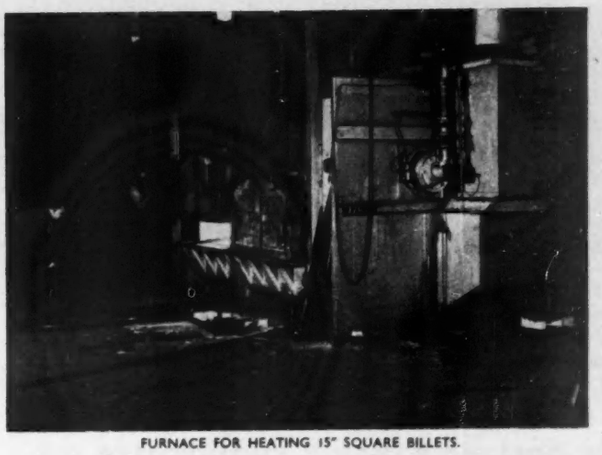

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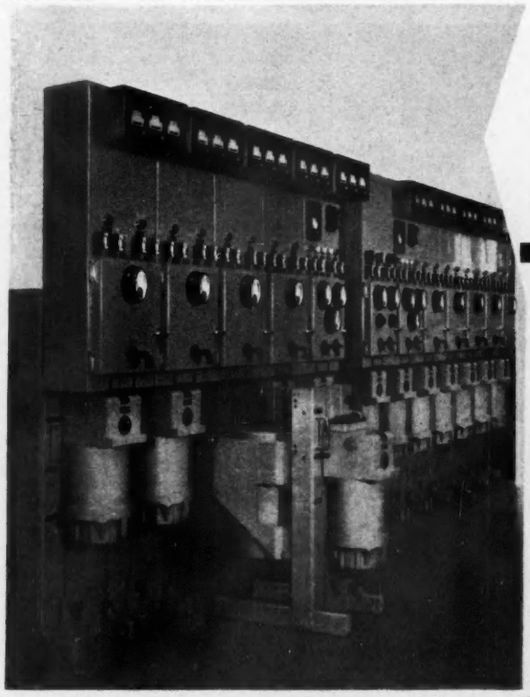

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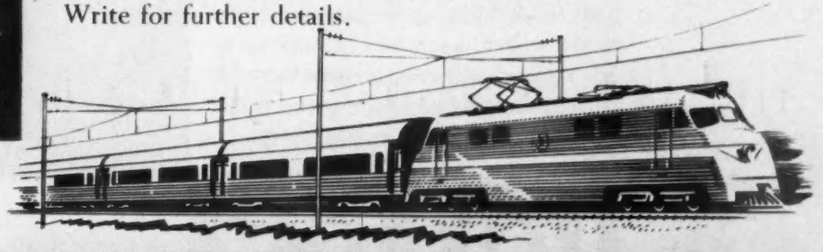

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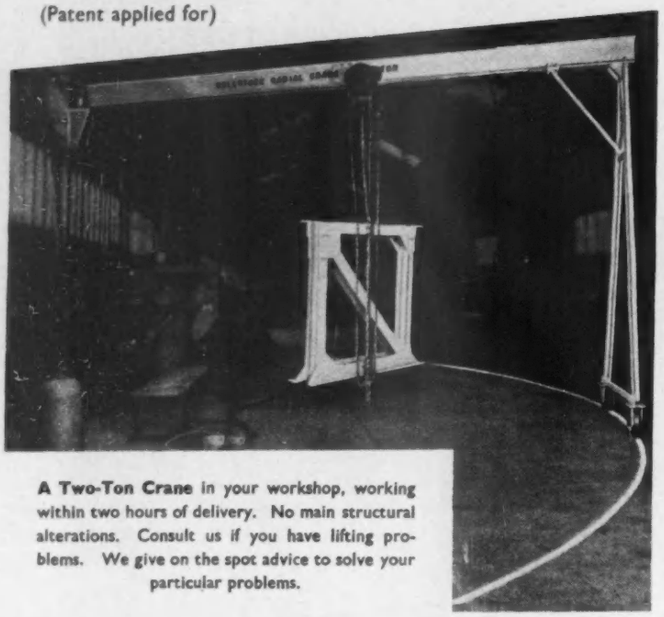

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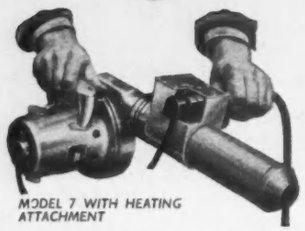

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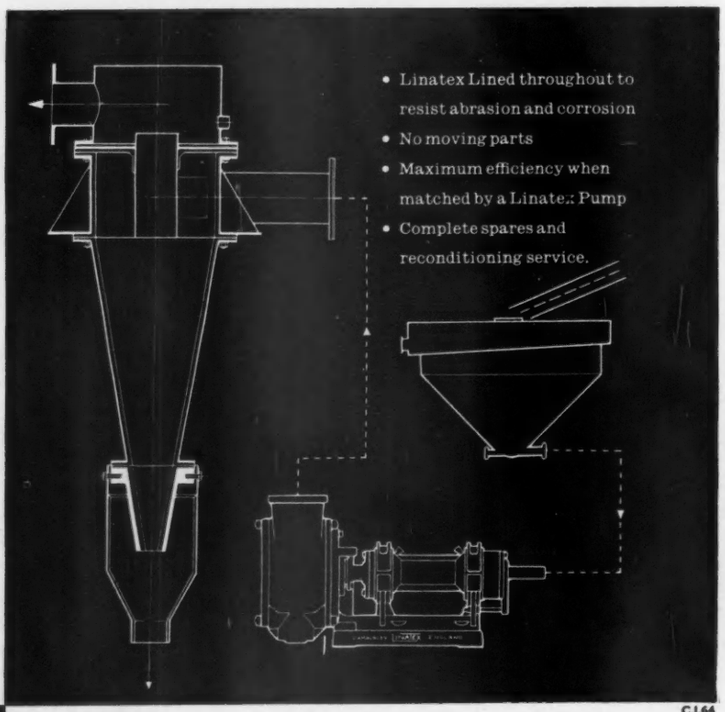

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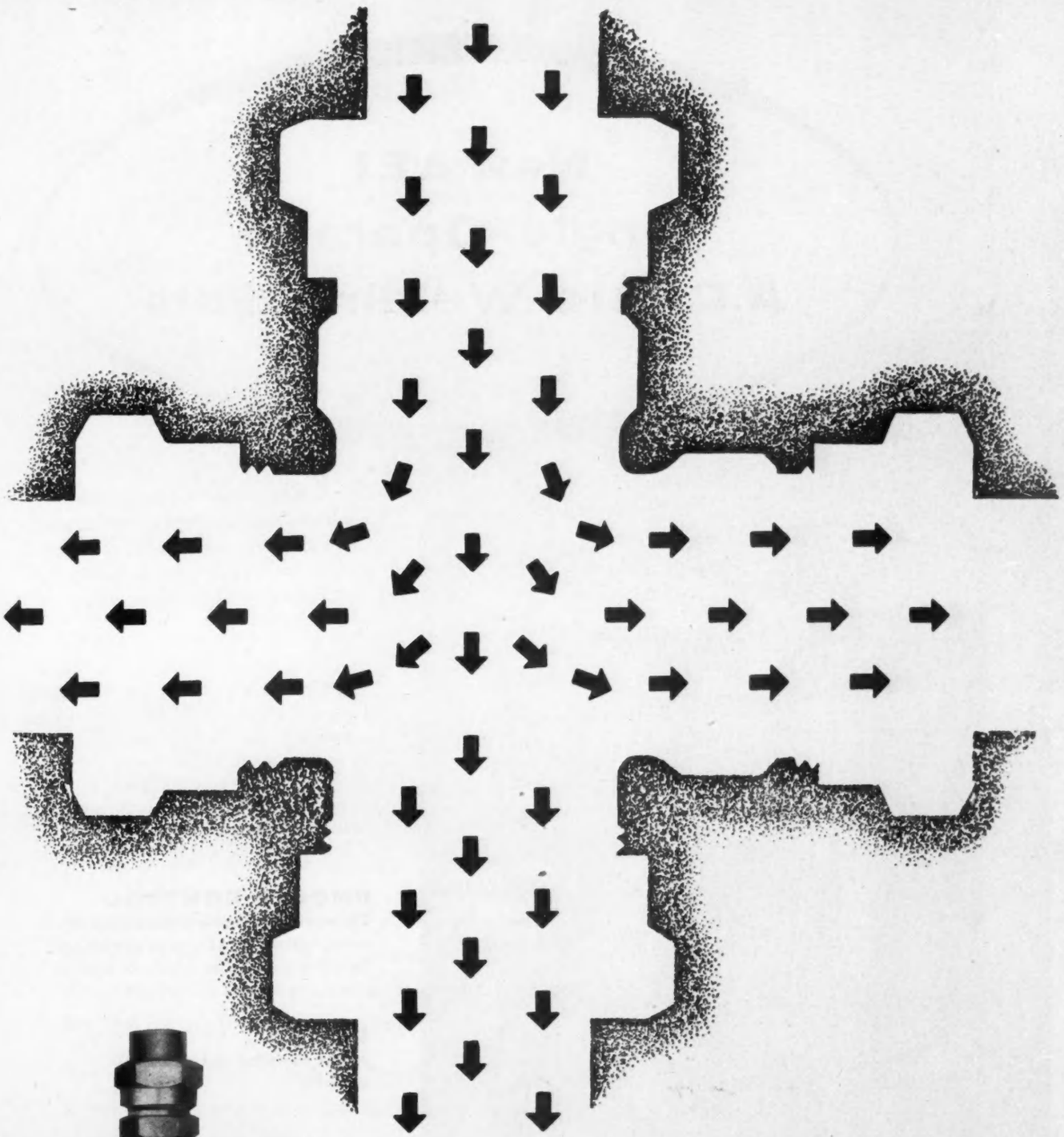

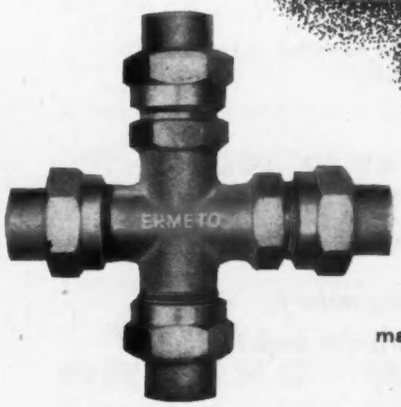

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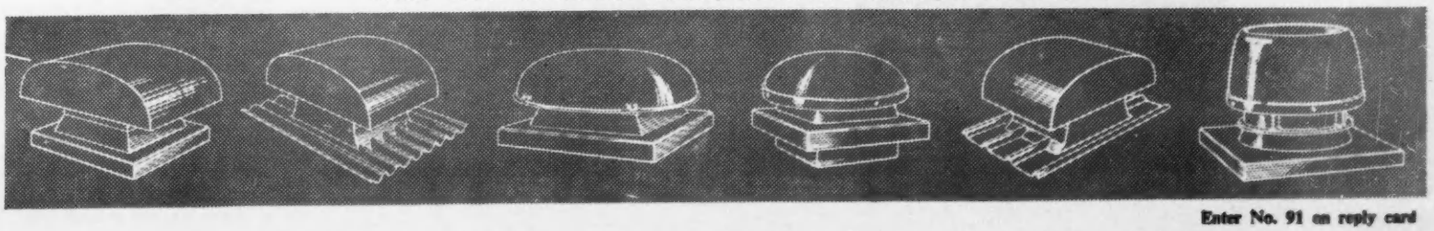

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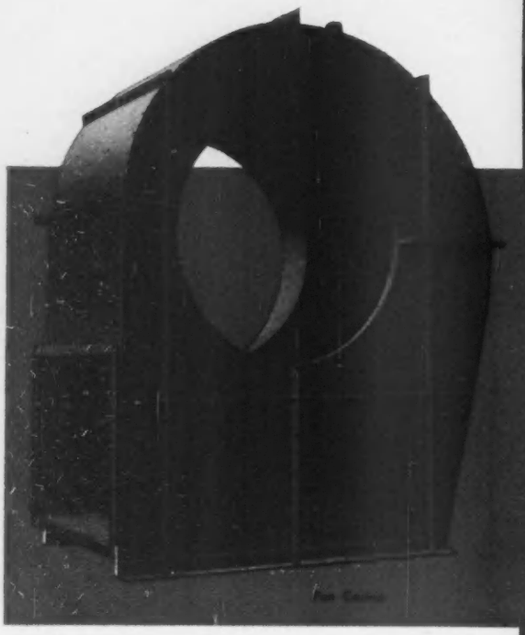

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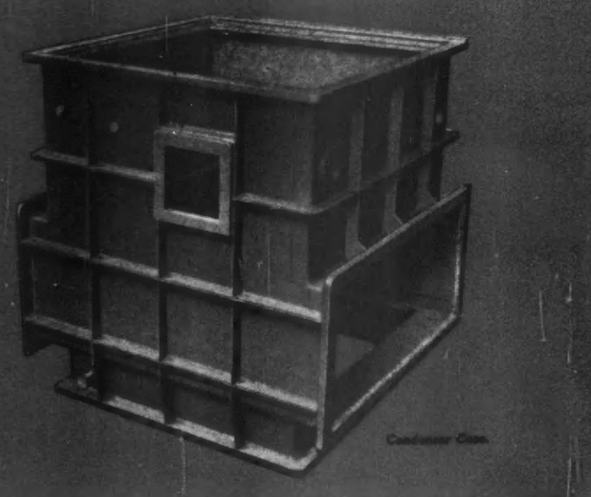

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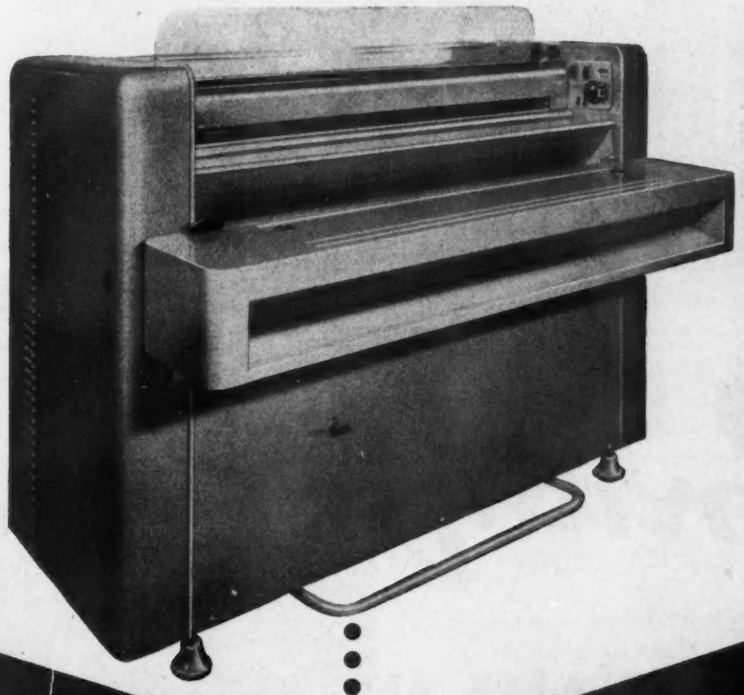

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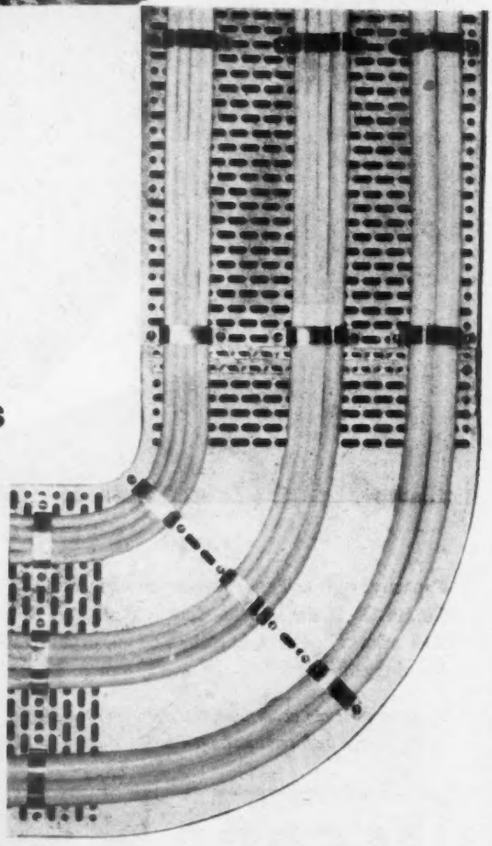

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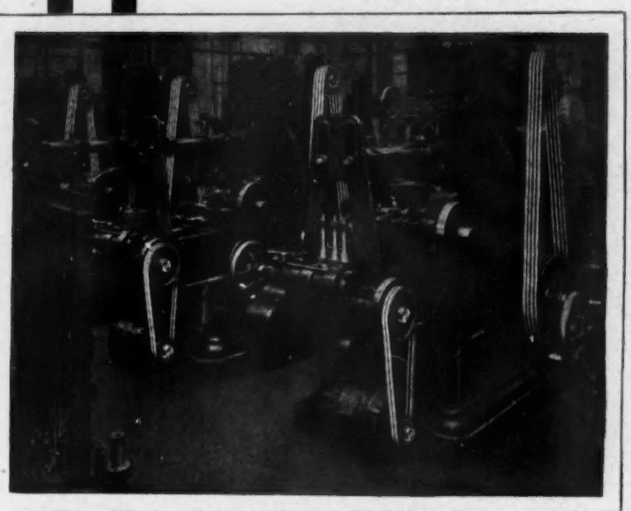

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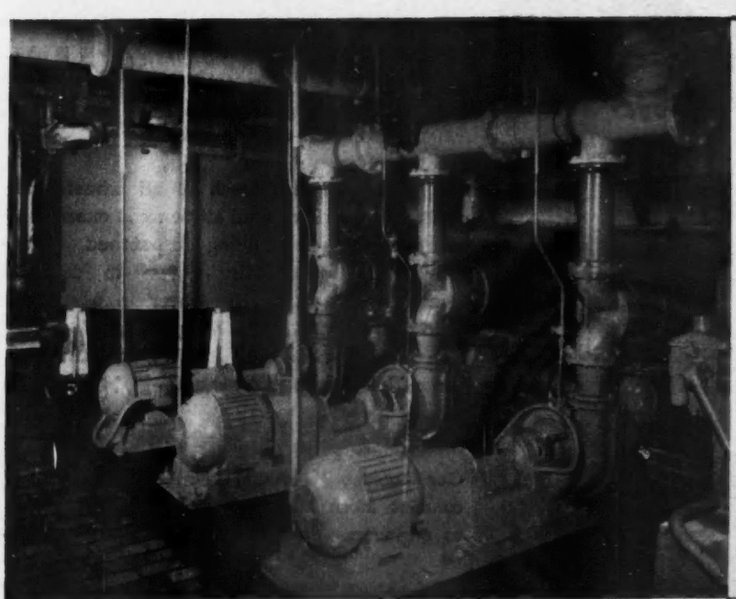

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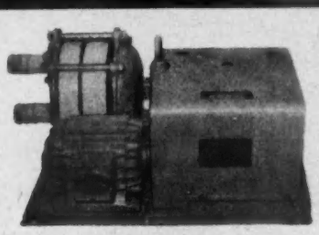
(Top left) Large battery centrifugal acid pumps
(Bottom left) Close-up view of diaphragm pump similar to the hand operated unit but arranged for motor drive
(Bottom centre) Hand operated portable diaphragm pump for emptying carboys or tanks and for general duties.
(Bottom right) Portable rotary displacement pump pumping plating solutions in the motor car trade



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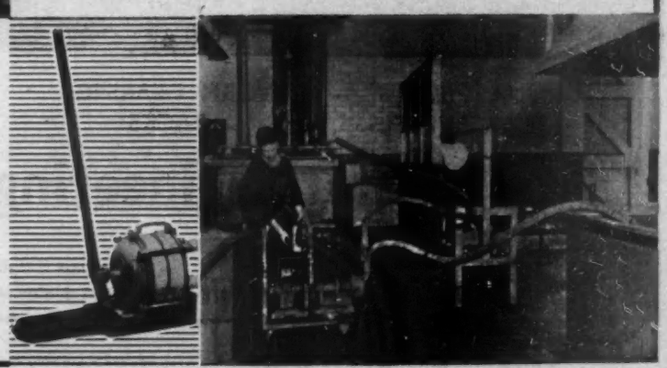

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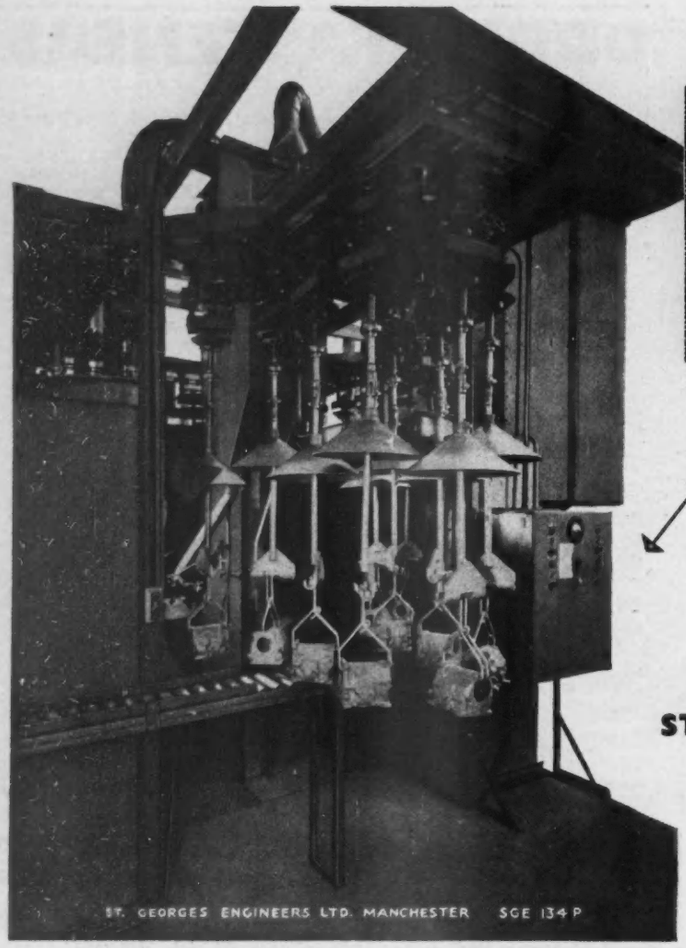

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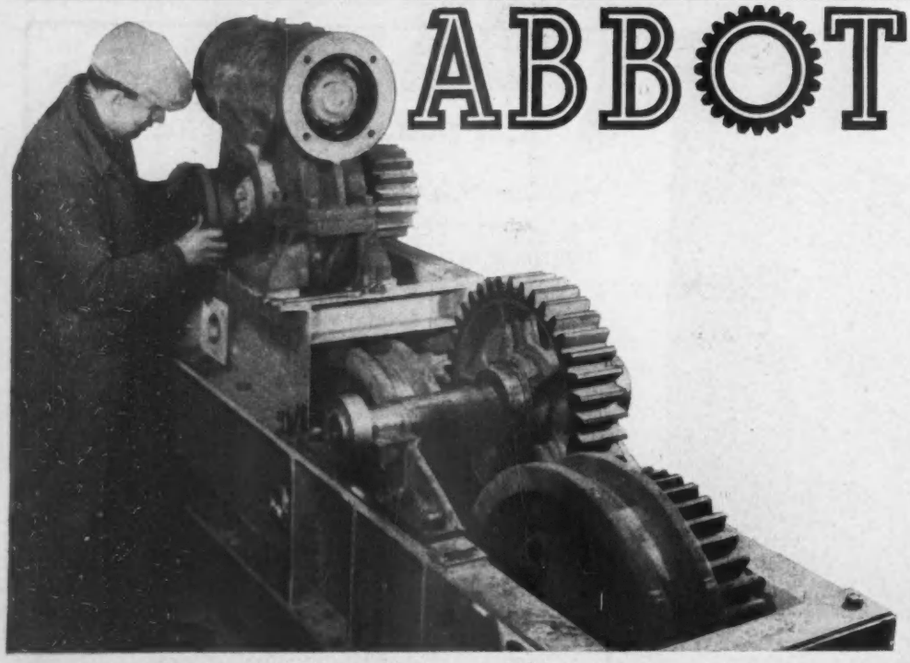

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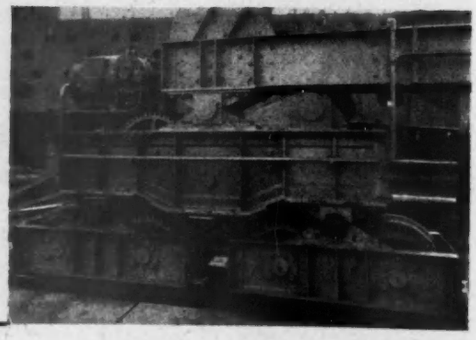

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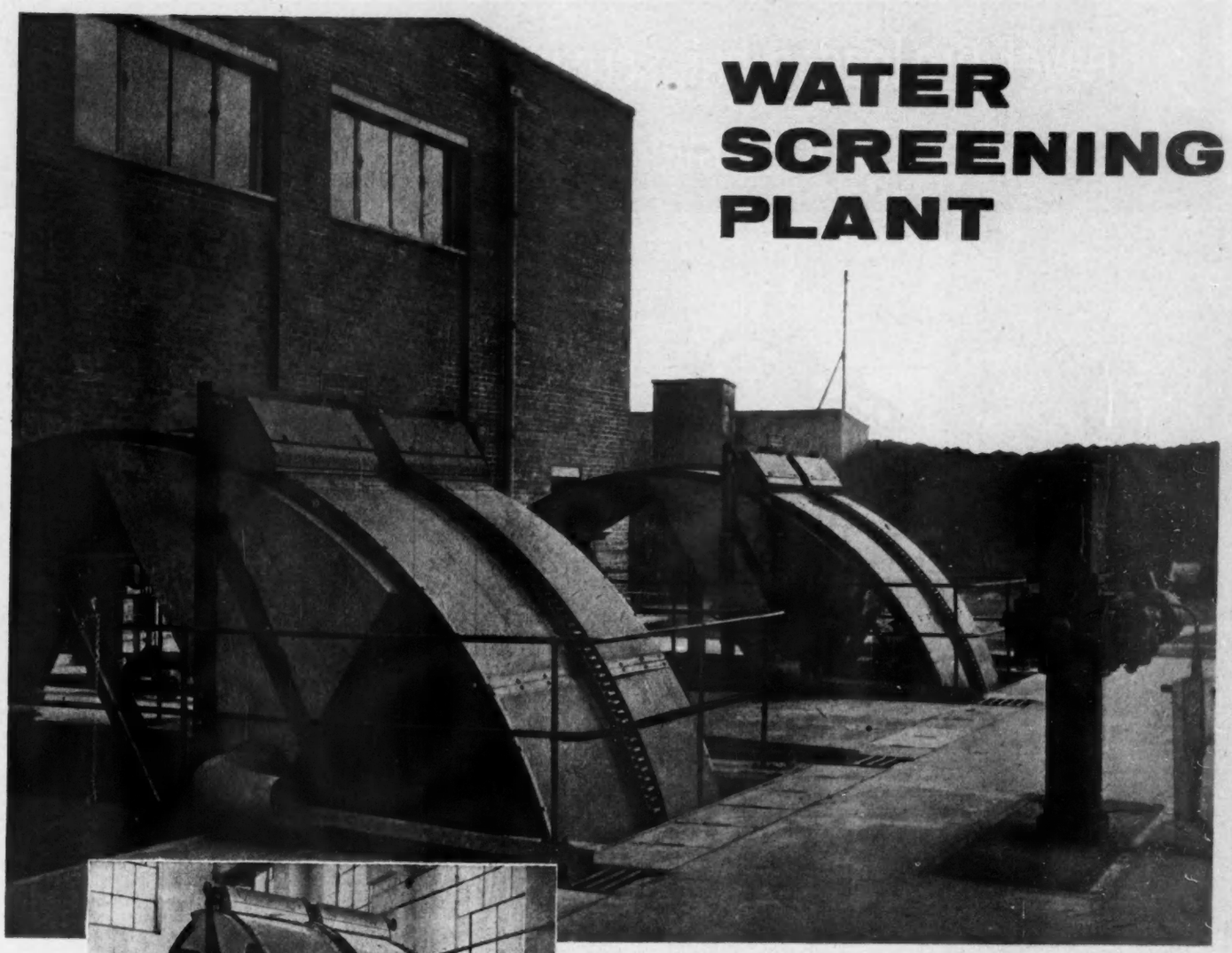

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The examples illustrated are of Revolving Drum pattern. Amongst recent orders for this type are the four 38ft. diameter units supplied for Kincardine Power Station of the South of Scotland Electricity Board ; and the six 30ft. diameter units at present in hand for Uskmouth Power Station, of the Central Electricity Generating Board.

The headstock visible on the right of the installation view belongs to the motor-operated screen chamber penstock—another notable Blakeborough speciality.

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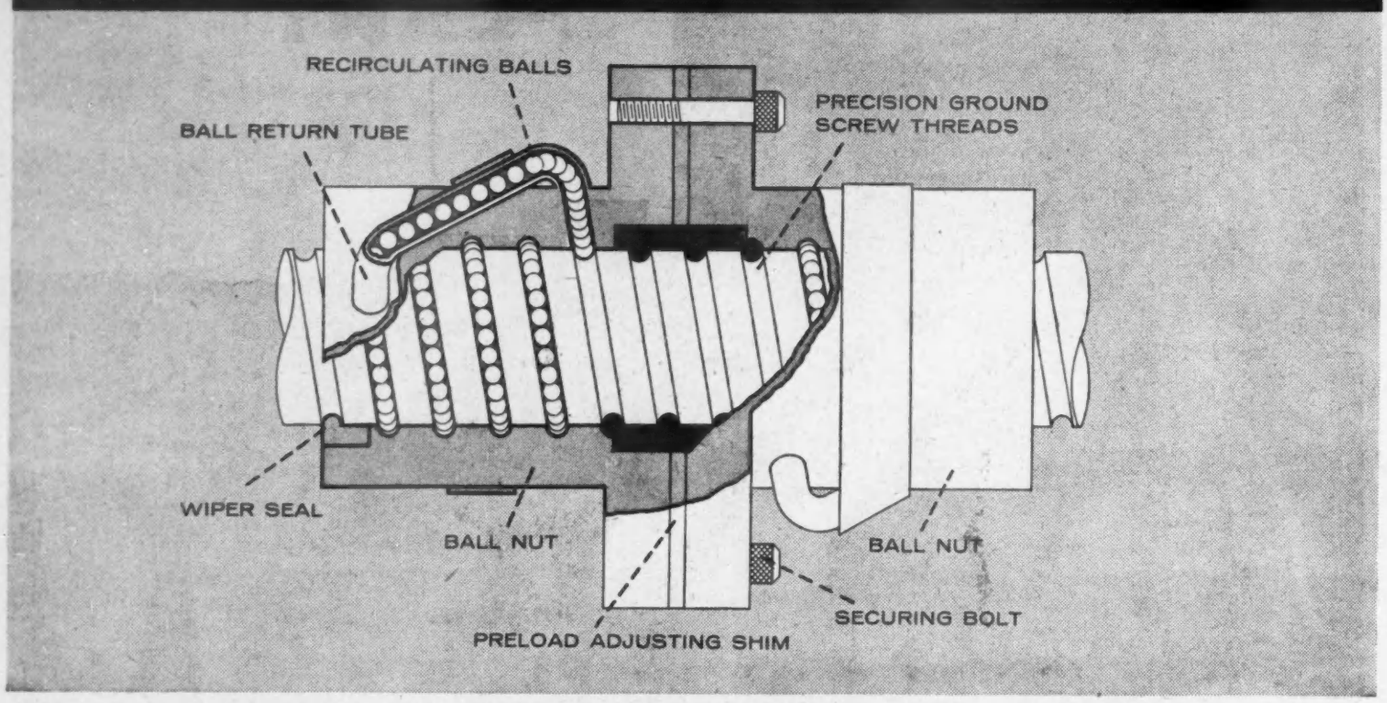
Beaver pre-loaded ball screws, up to 95% efficient, operate at -52°C to over 400°C with no backlash...



...ANOTHER ENGINEERING ADVANCE FROM BRISTOL SIDDELEY

Bristol Siddeley Engines Limited produce Beaver* pre-loaded ball screws. These ball screws achieve a minimum efficiency of 90% and they can operate within a temperature range of −52° C to 400° C without lubrication, and up to 170° C when lubricated.

Machined and ground to the highest standards of precision engineering Beaver pre-loaded ball screws greatly increase transmission efficiency. They reduce the power required for actuation by as much as 80%, when converting rotary drive into linear output or force input into torque output. By eliminating backlash, with pre-loading, they give precise control over very small increments of motion and a high response frequency. And when compared to conventional screw mechanisms, they provide a predictable operating life which is much longer, require much less maintenance and give more trouble-free operation.

Basic design application analysis

Bristol Siddeley engineers make an exhaustive analysis of each specification. And each unit is specially designed for its particular application. Beaver ball screws are made automatically reversible or with controlled "no-back," with multiple or single circuits. Beaver pre-loaded ball screws have been proved as the most efficient method of converting rotary into linear thrust in over 2,700 engineering applications in many branches of industry. They have been designed already with rated operating load capacities of 370,000 lb (825,000 lb maximum static load) but the maximum potential operating load is, in most cases, limited only by the requirement.

Bristol Siddeley Beaver ball splines have been developed to eliminate the disadvantages of conventional splines. The designs are very effective in minimising friction, particularly when high torsional and bending loads are imposed during linear movement.

* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

For further information please write to:

J. B. STARKY, SALES MANAGER (BEAVER PRODUCTS DIVISION), BRISTOL SIDDELEY ENGINES LIMITED, PO BOX 17, COVENTRY, ENGLAND.

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Why do you use a T.V. Belt Dad?

A tricky question from such a young fellow—at first sight. A V-Belt drive however, is a relatively simple method of power transmission, but it is important to realise that the construction of V-Belts differs enormously. The main reason why most people use T.V. Belts (Turners V-Belts) for industrial duties, is that the strength of a T.V. Belt lies at the neutral axis, which ensures thousands of hours of trouble-free running. To sum up briefly—a T.V. Belt gives improved performance with considerably reduced maintenance costs; childishly simple—but of first importance to the user.

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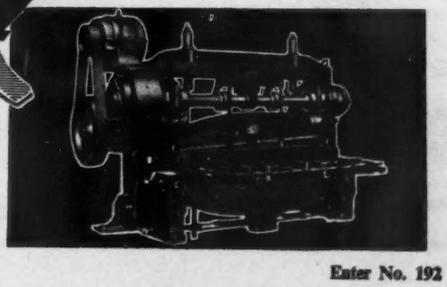

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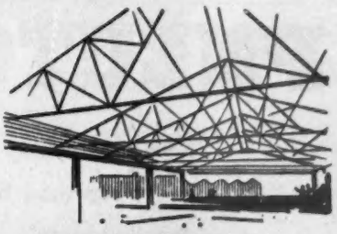

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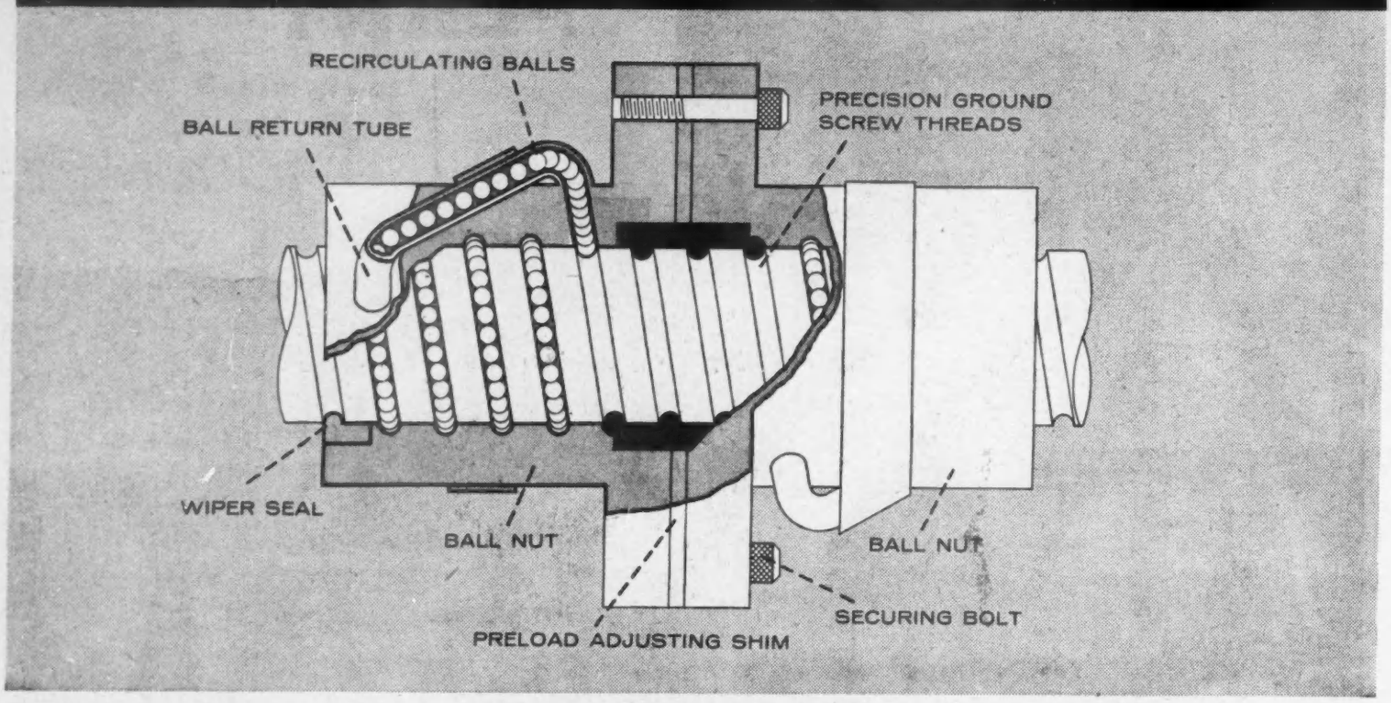

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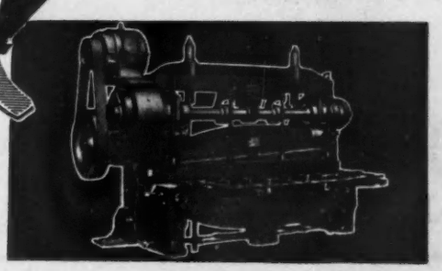

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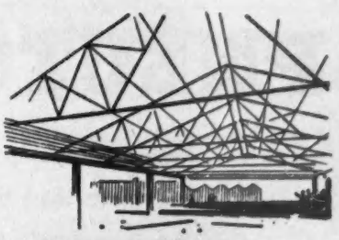

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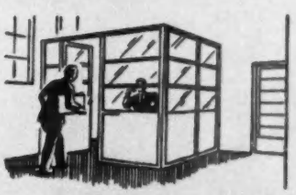

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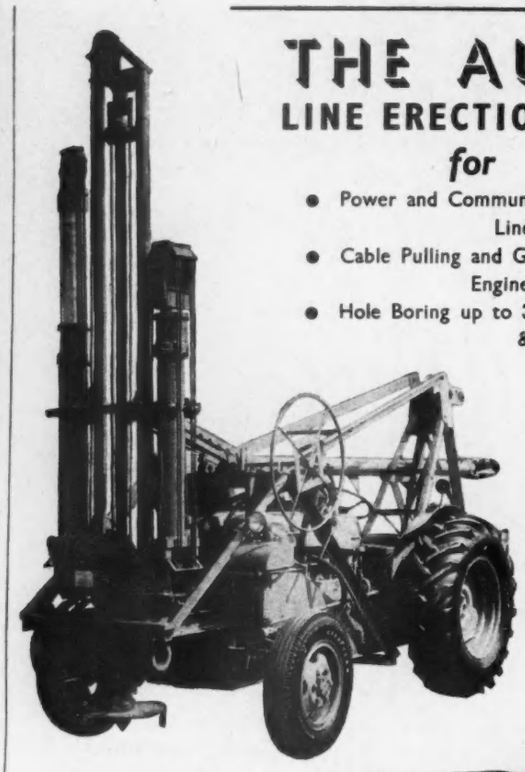

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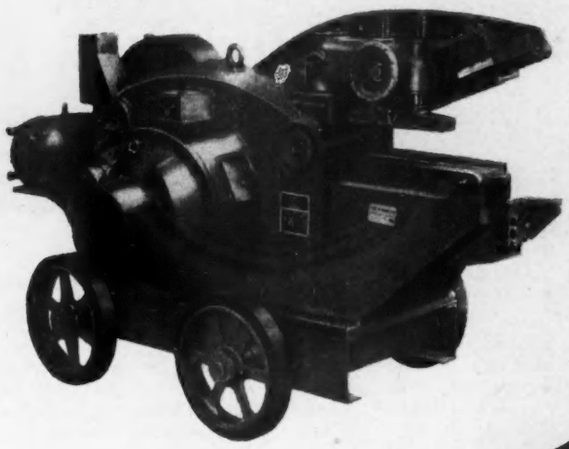
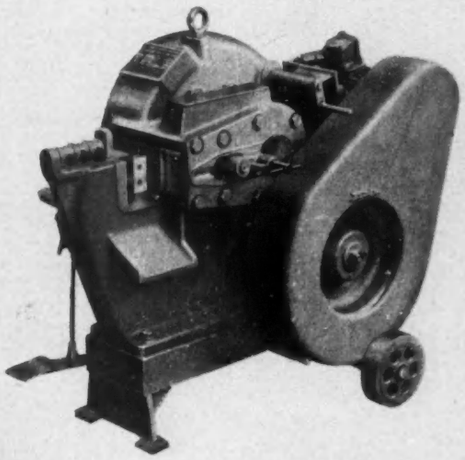
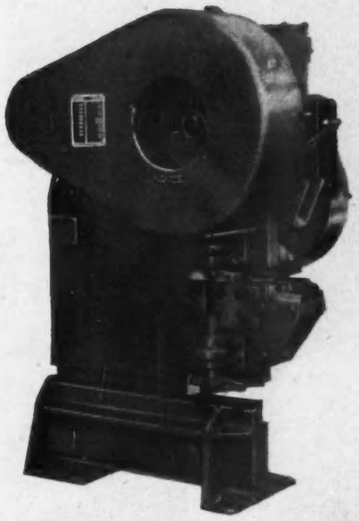
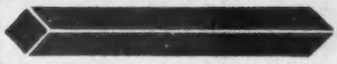




ALLIGATOR SHEARS; four sizes, capacities 1⅞in. to 4½in. M.S. rounds, etc., gears running in oil; clutch control; adjustable hold down; electric or diesel engine drive.

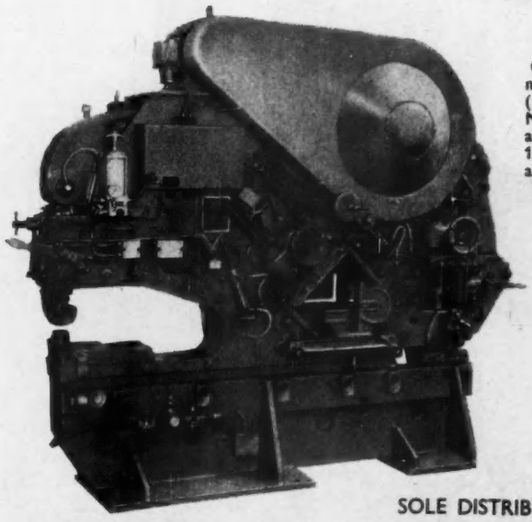


PORTABLE BAR SHEARS; five sizes, capacities 1in. to 2¾in. M.S. rounds; gears running in oil; clutch control.

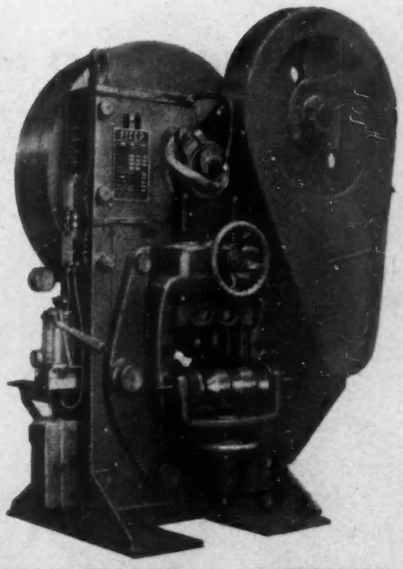


UNIVERSAL PUNCHING, SHEARING CROPPING and NOTTING MACHINES five sizes, capacities shearing ⅜in. to 1in M.S. plates, etc.; five operations contained in one power driven unit. Alternative models; without punching motion and single purpose punching machine.

BILLET and BAR SHEARS; nine sizes, capacities from 1in. to 8in. dia. M.S. bars; power feed tables, fully automatic operation can also be supplied.



COLTS' SHEARING MACHINE Basic machine (Type 1) has shearing capacities (M.S. flats) up to 3½in. × ½in., and slitting M.S. plates up to ½in. thick. Type 2 has also bar cropping facilities handling up to 1½in. dia., 1½in. square. Type 3 incorporates a notching unit.



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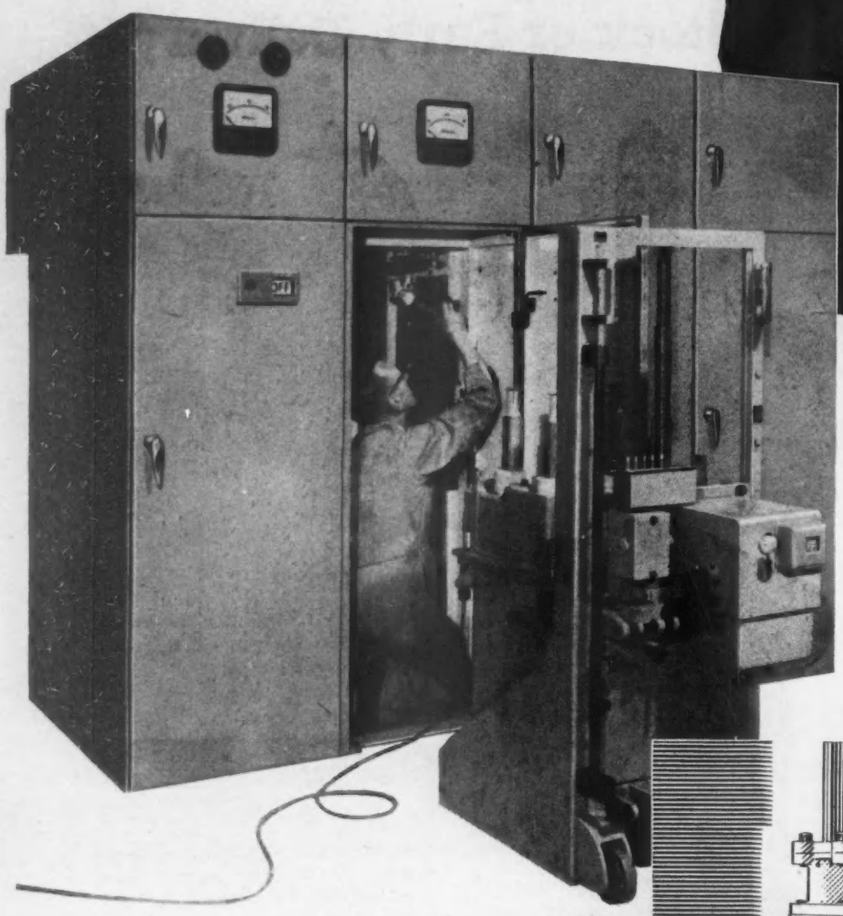

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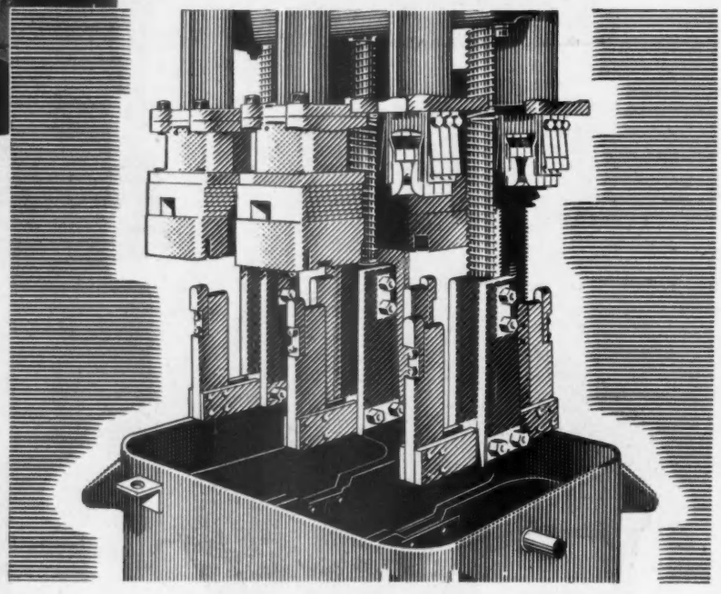

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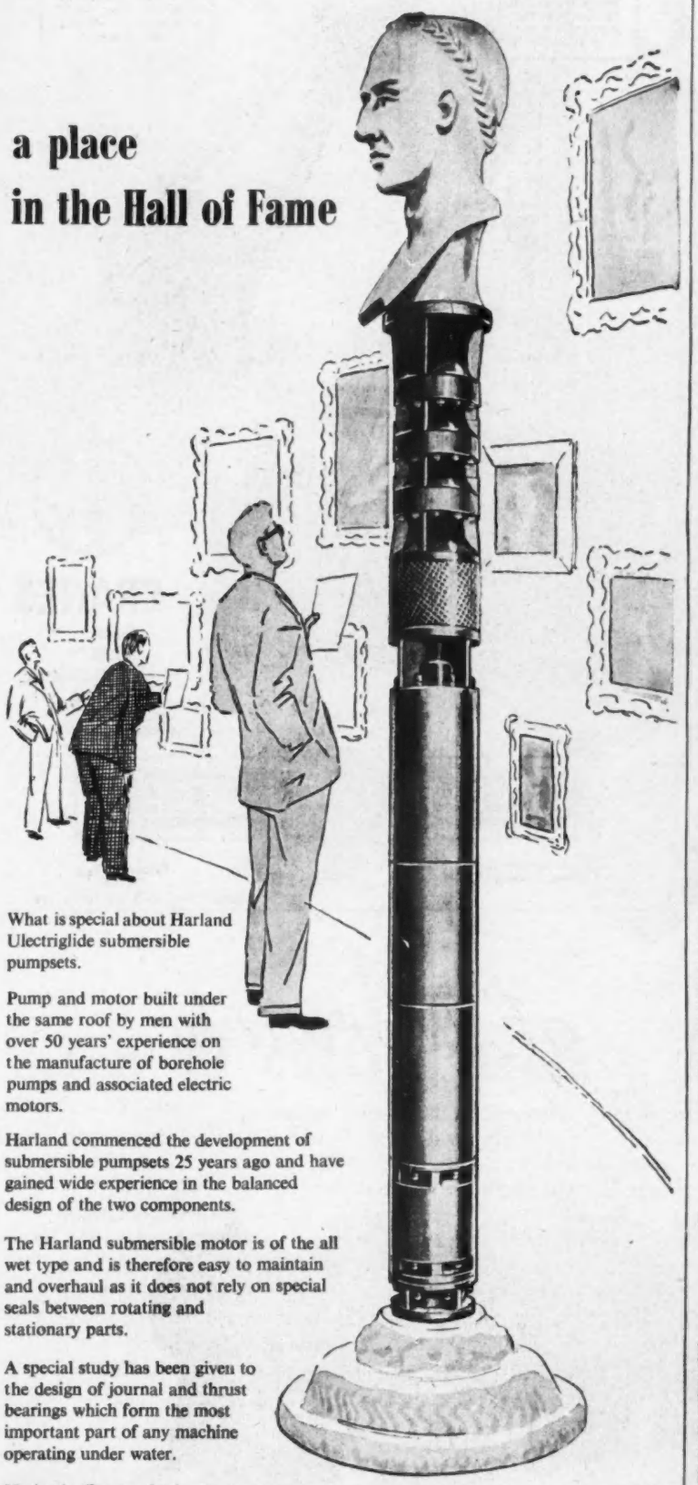

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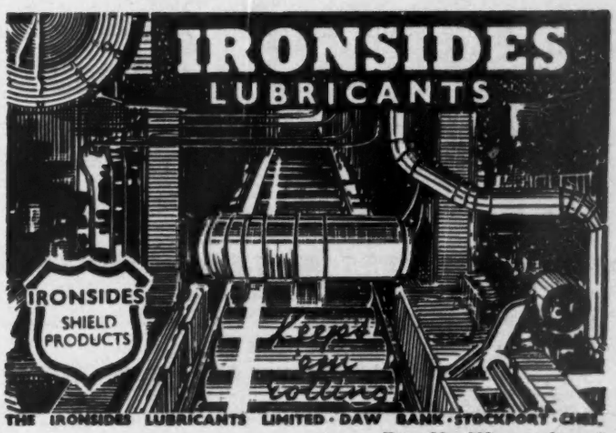

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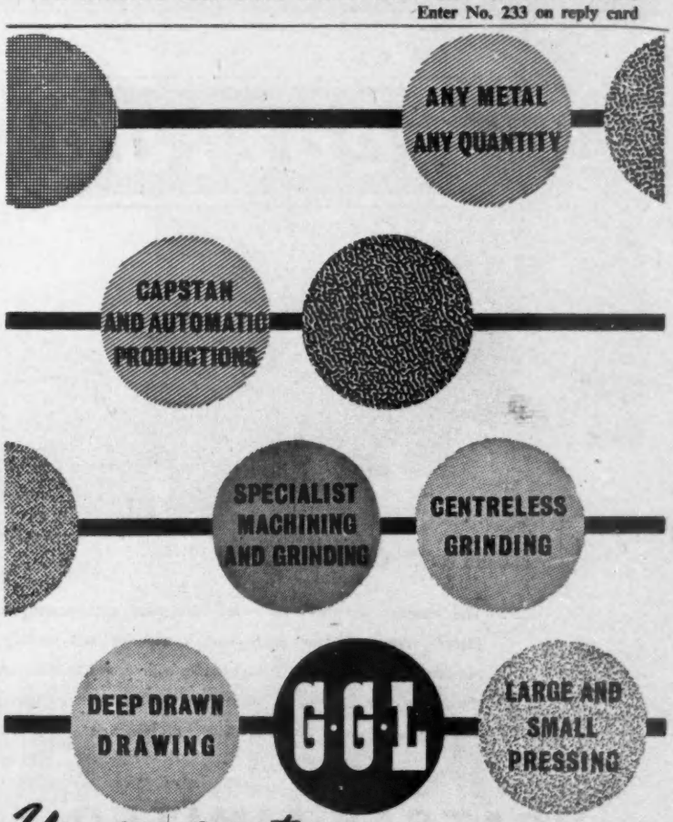

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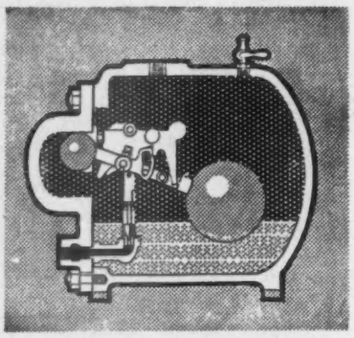

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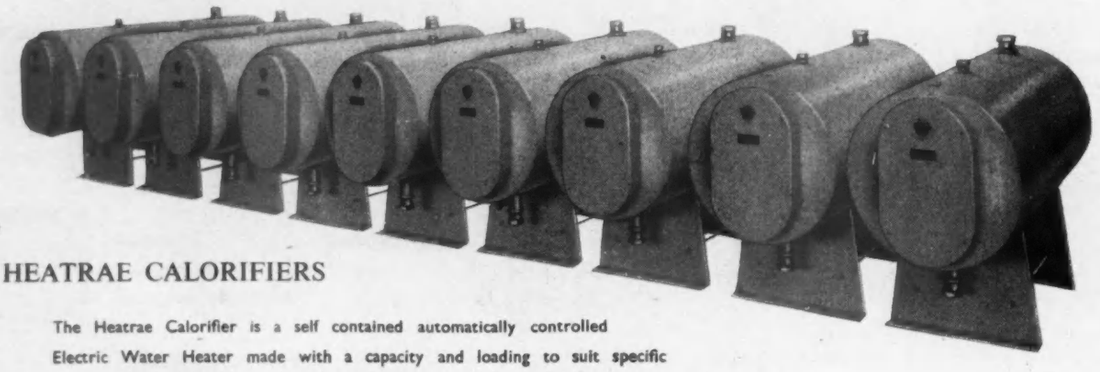

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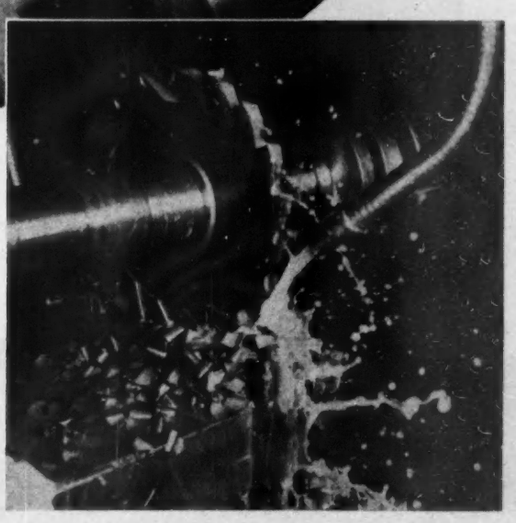

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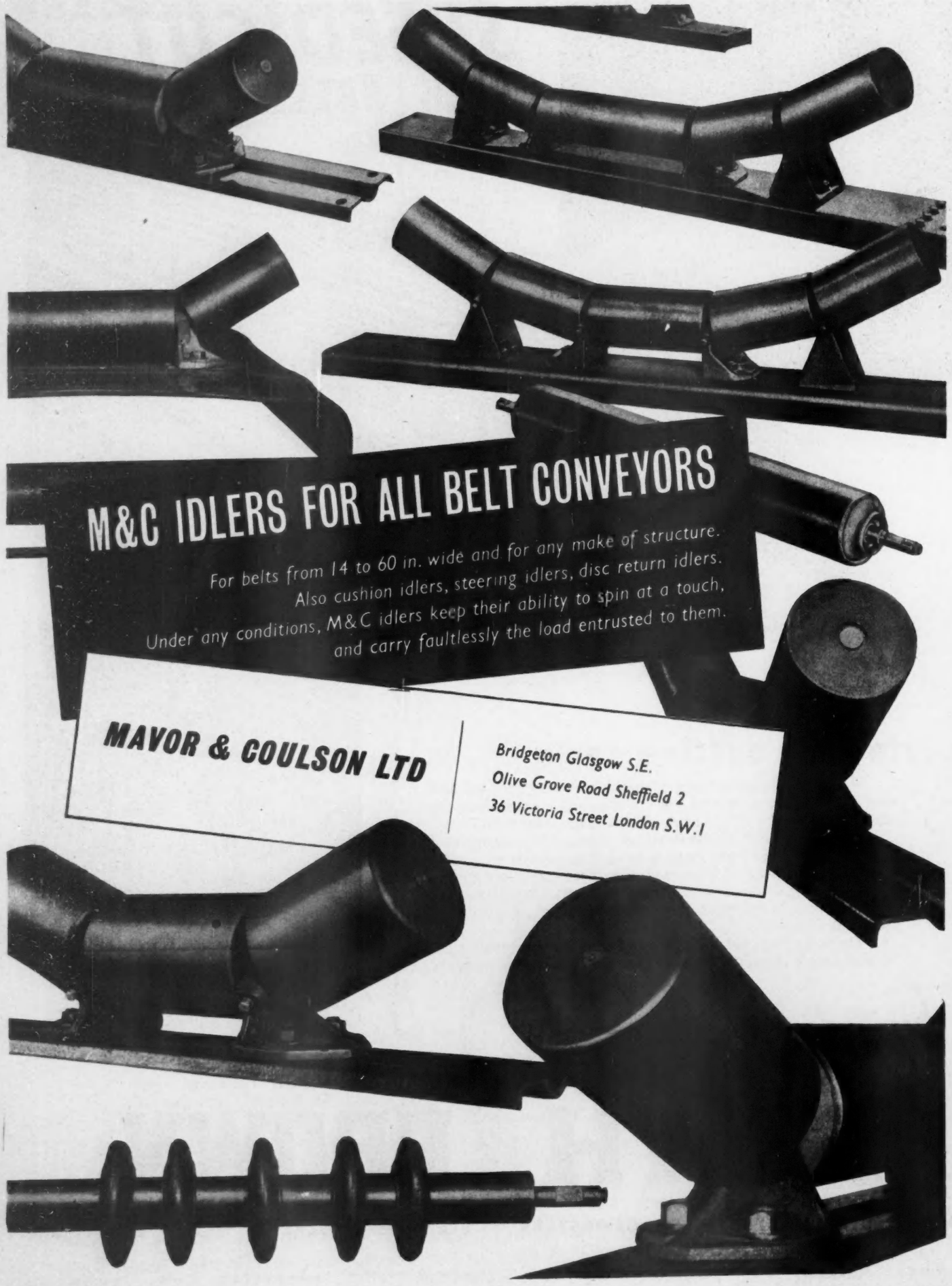

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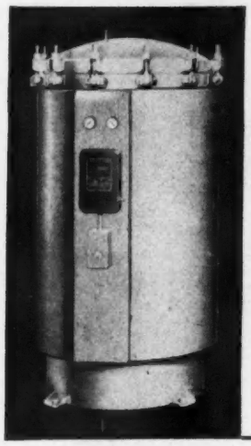

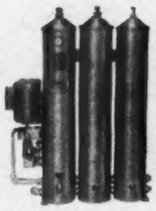

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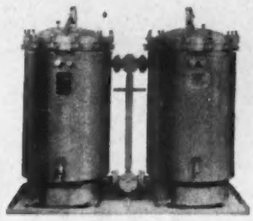

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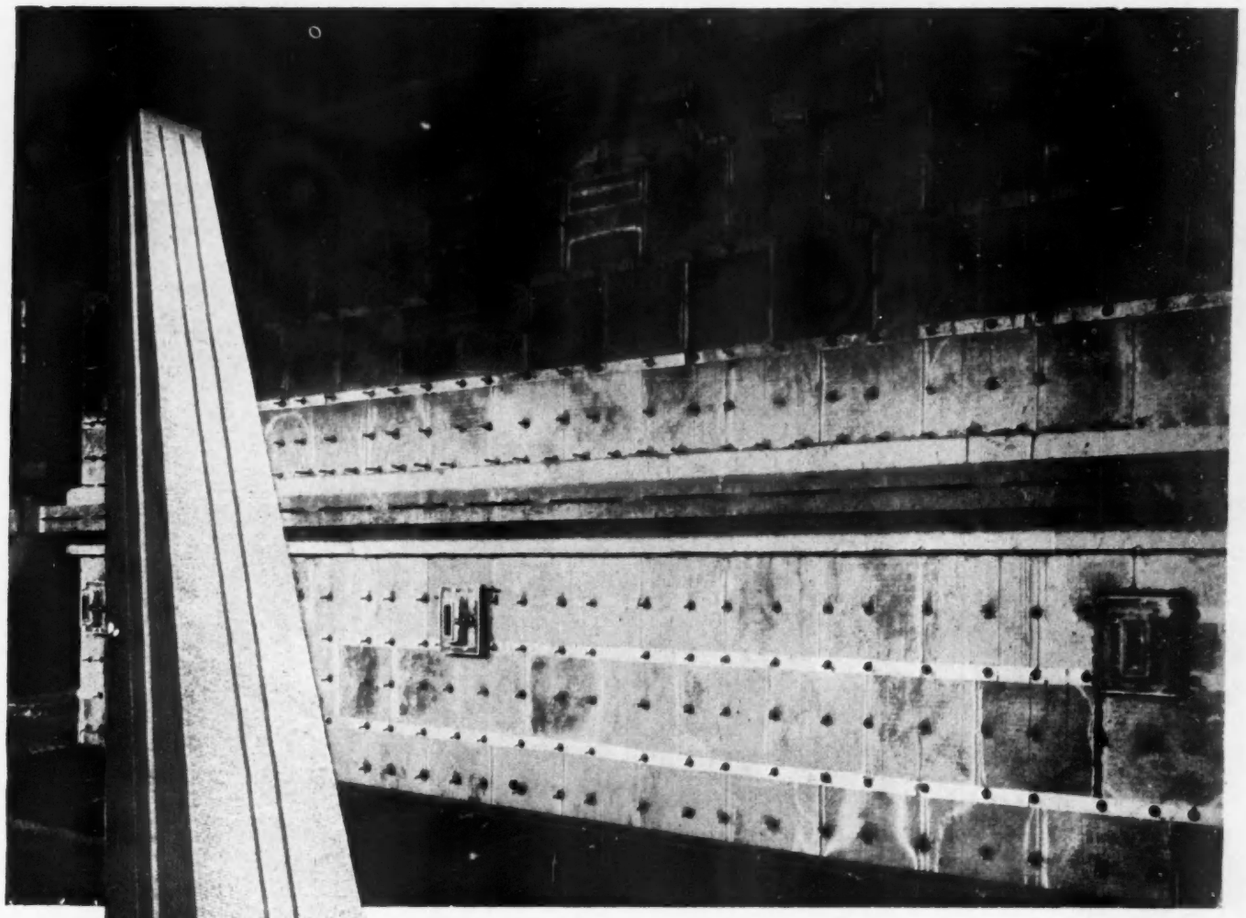

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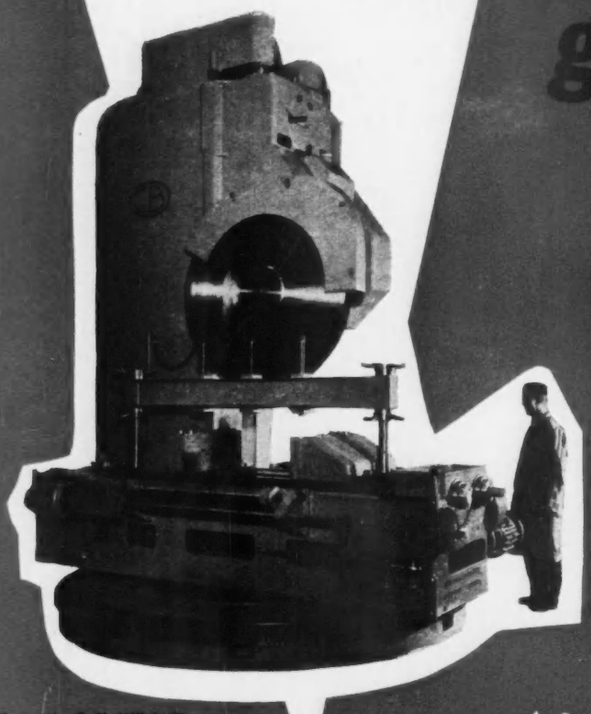

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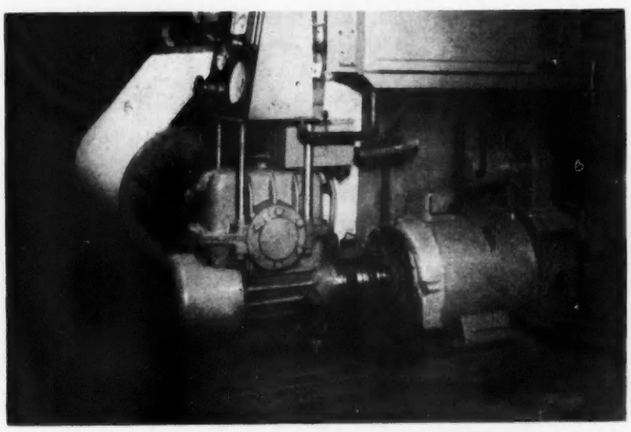

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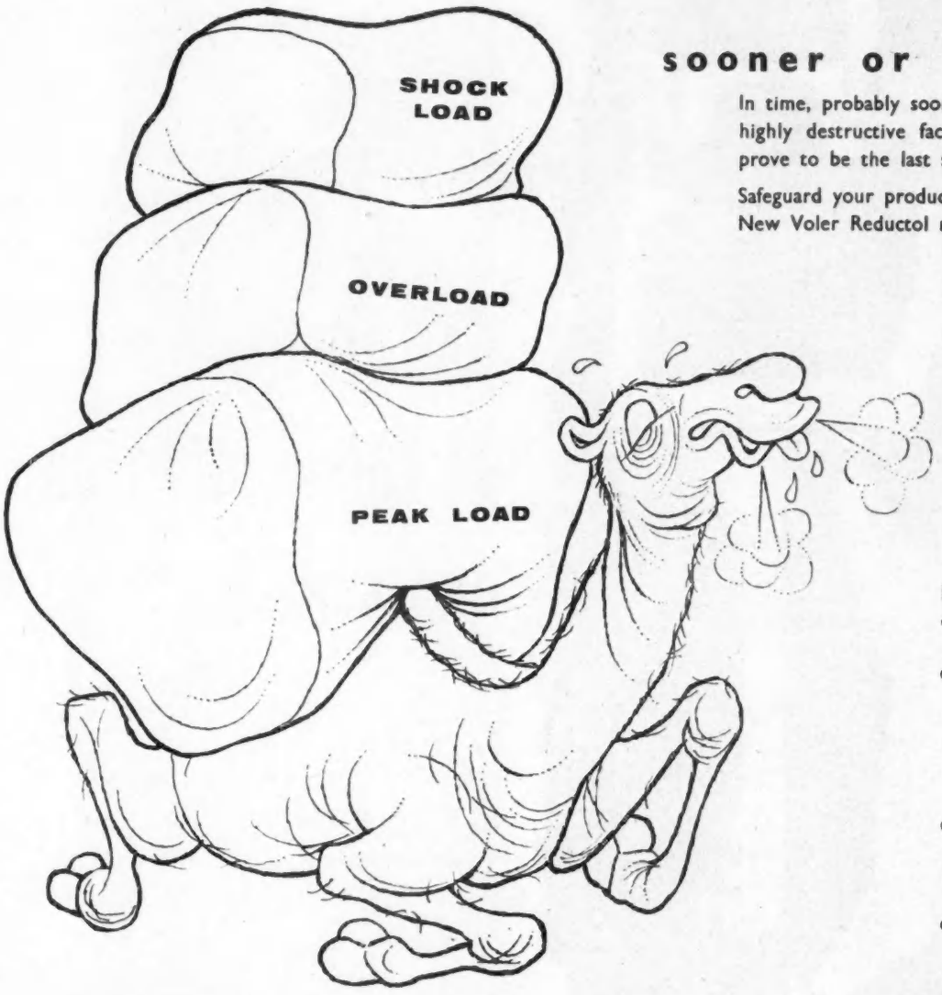

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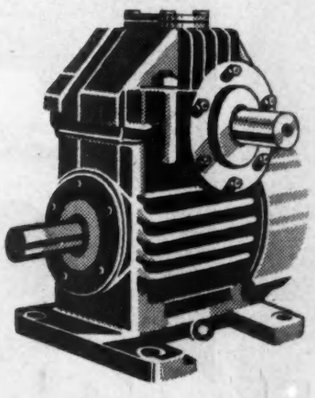

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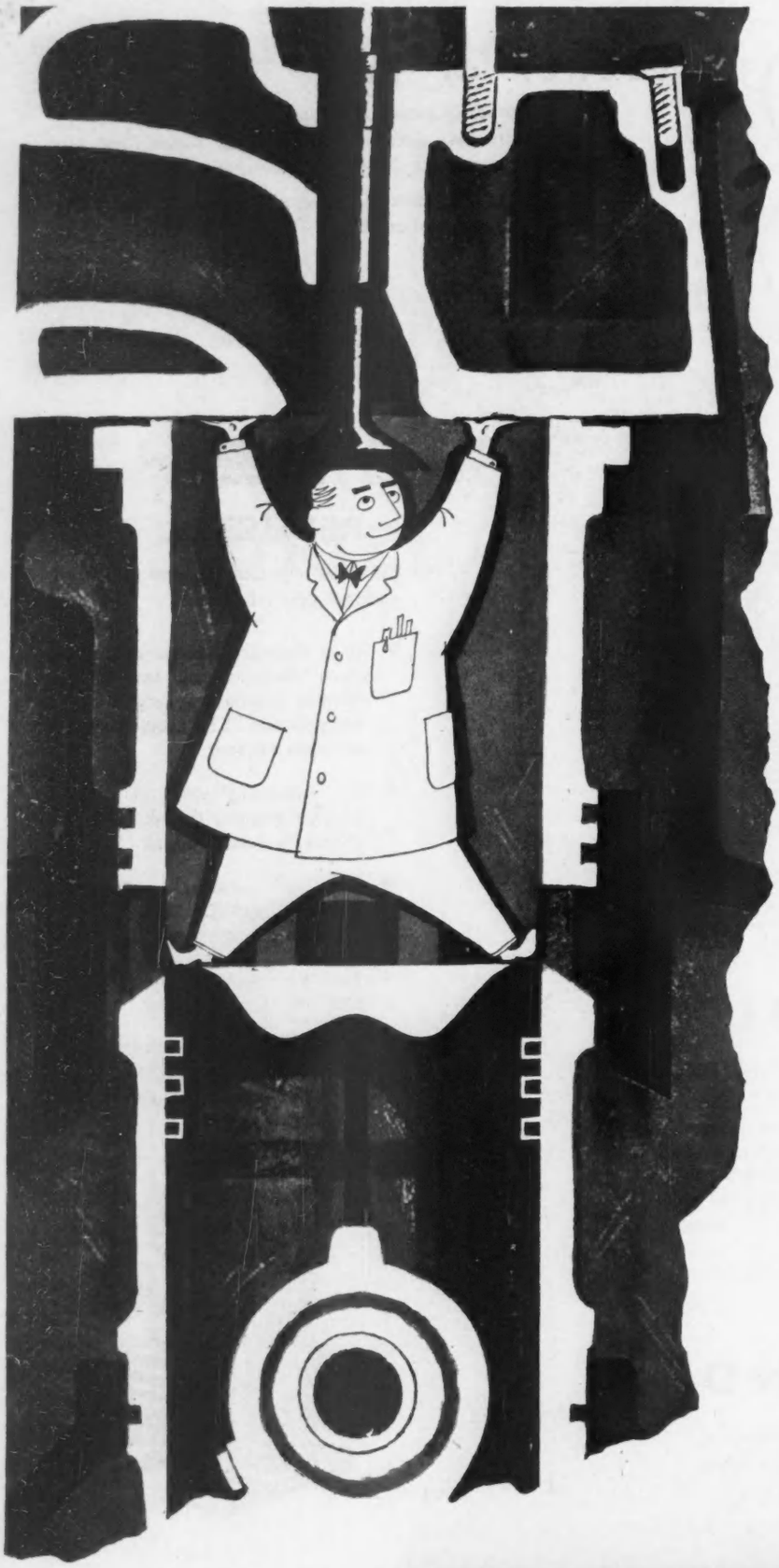

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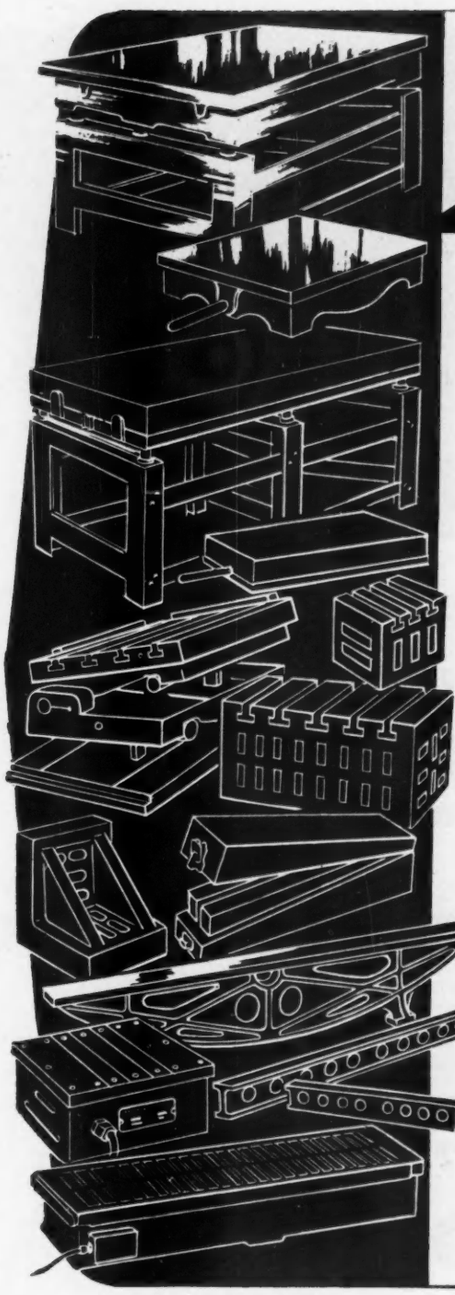

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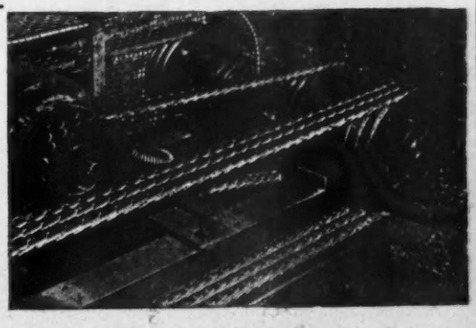

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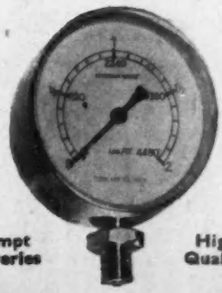

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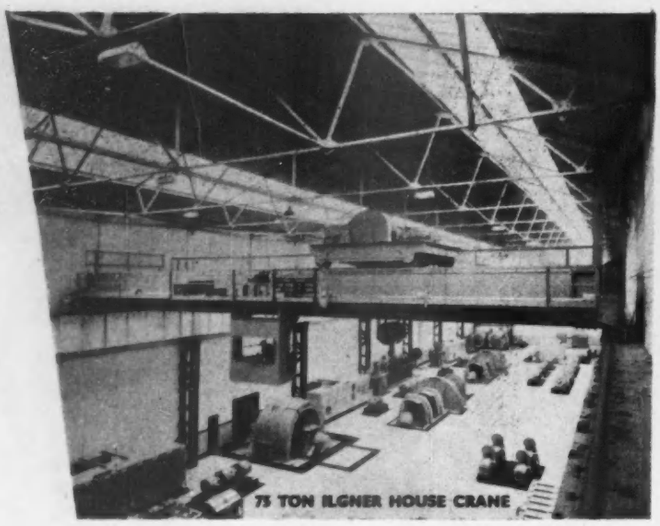
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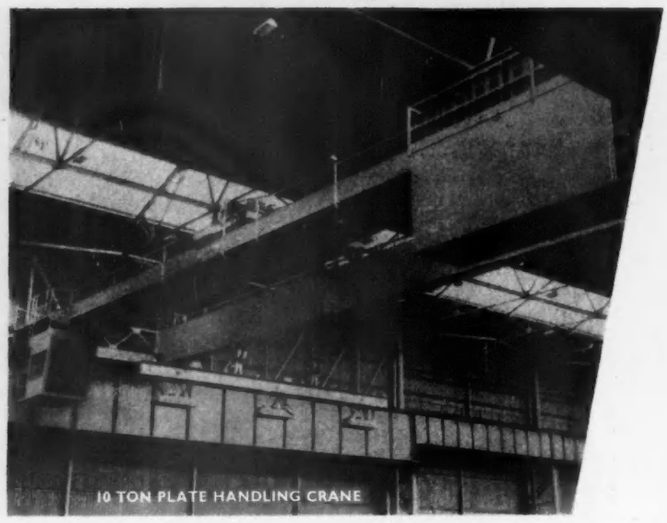
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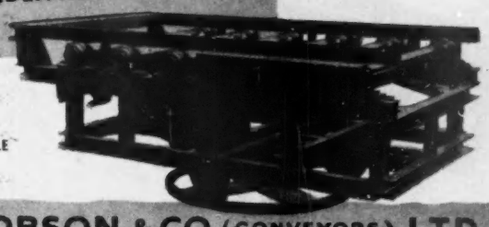

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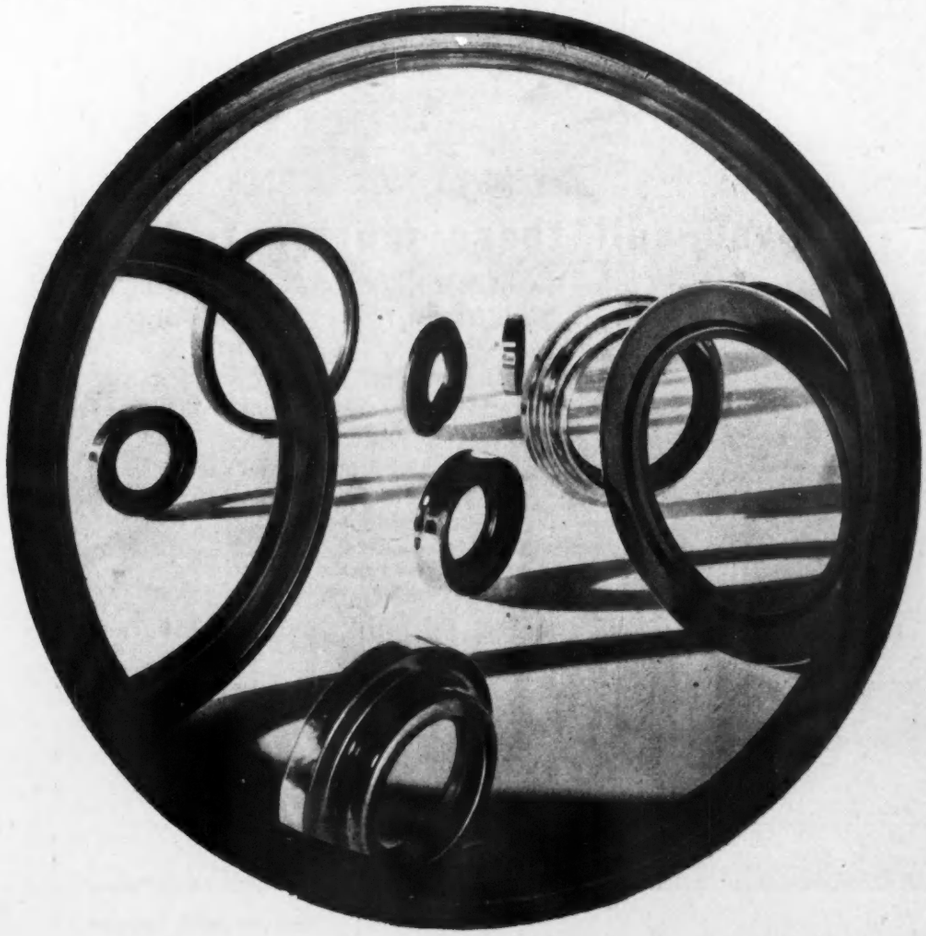

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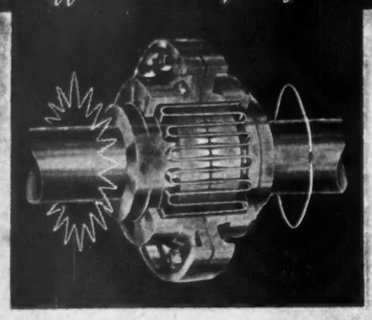

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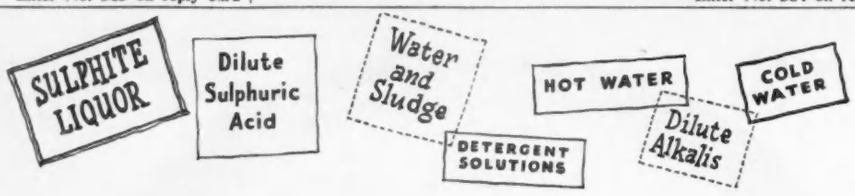

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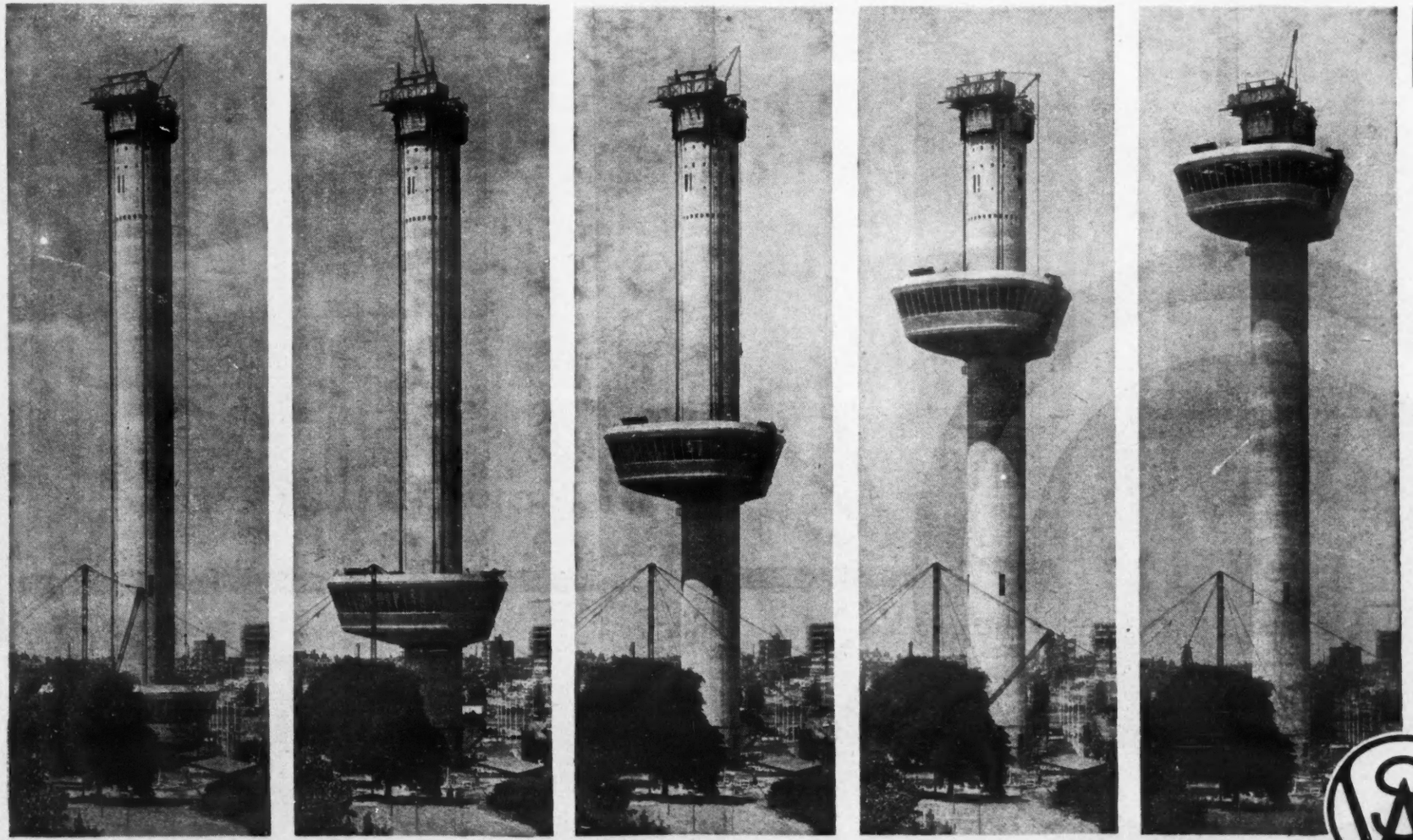

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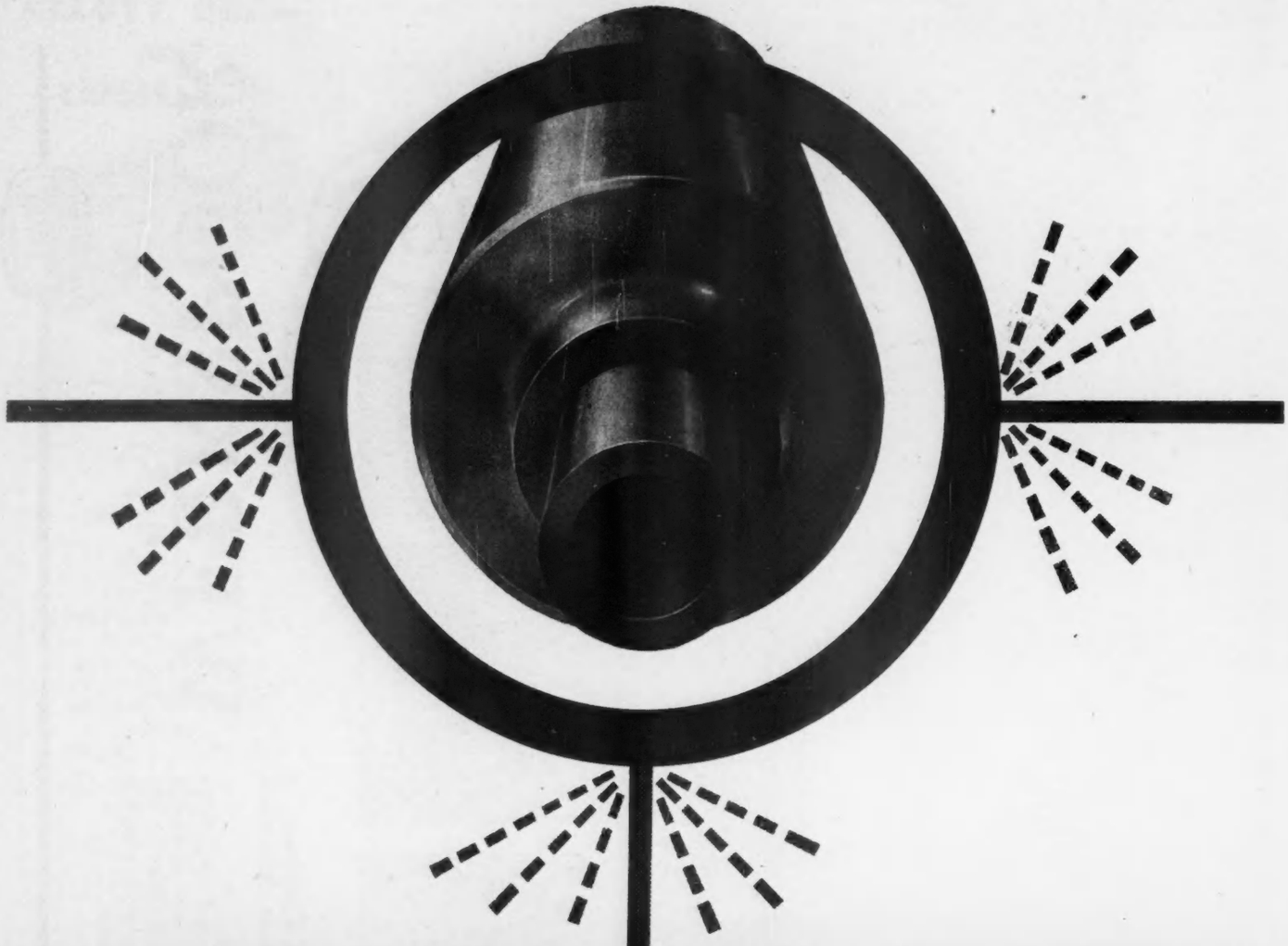

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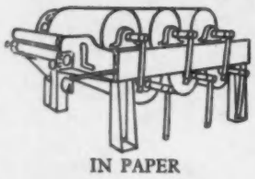

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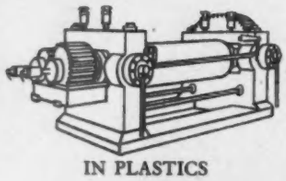

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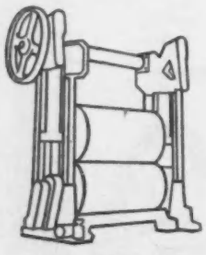

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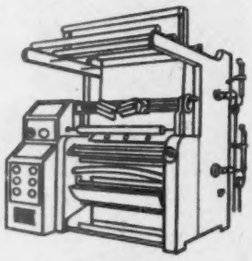

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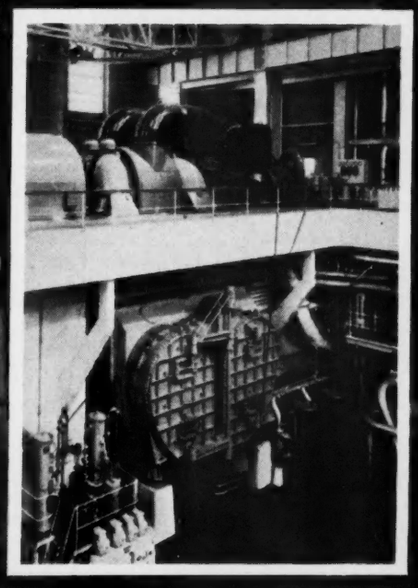

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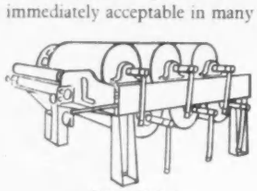

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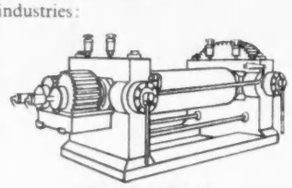

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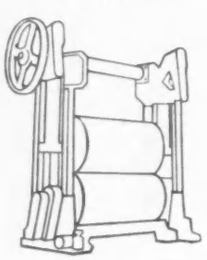

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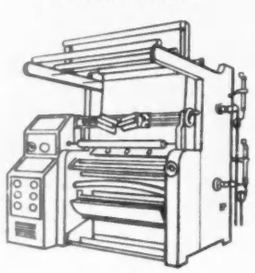

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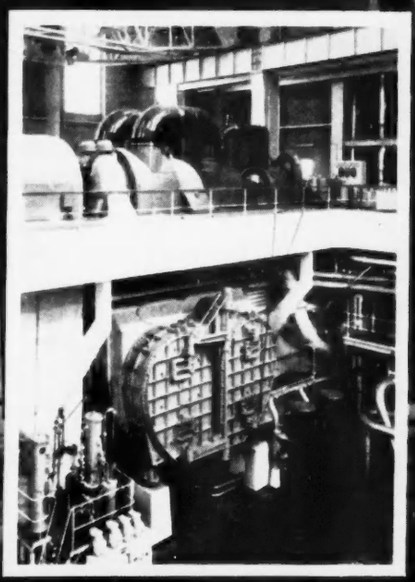

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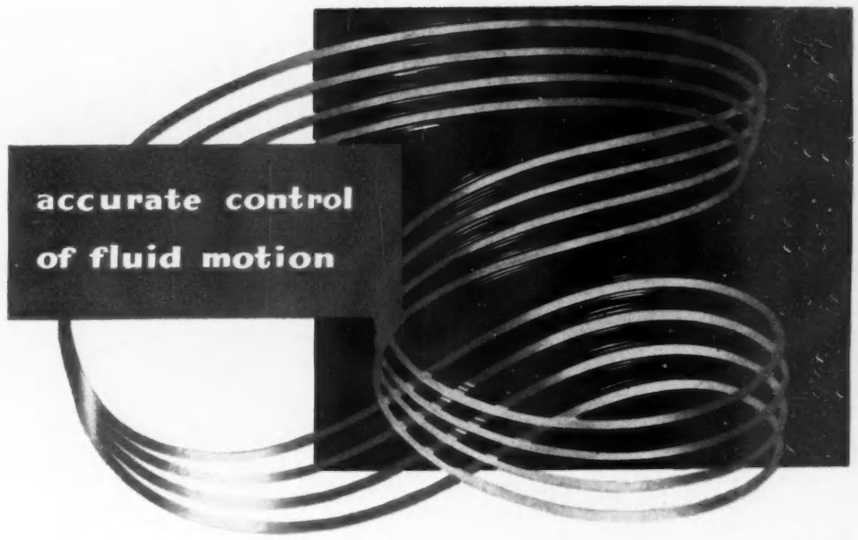

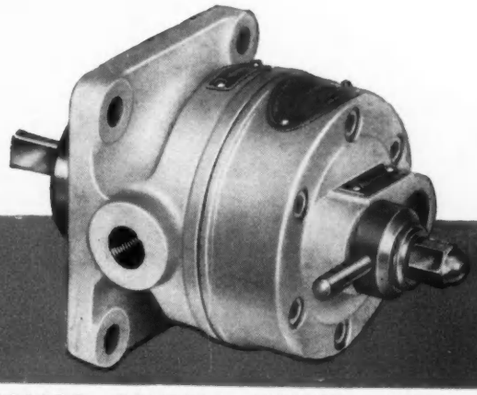

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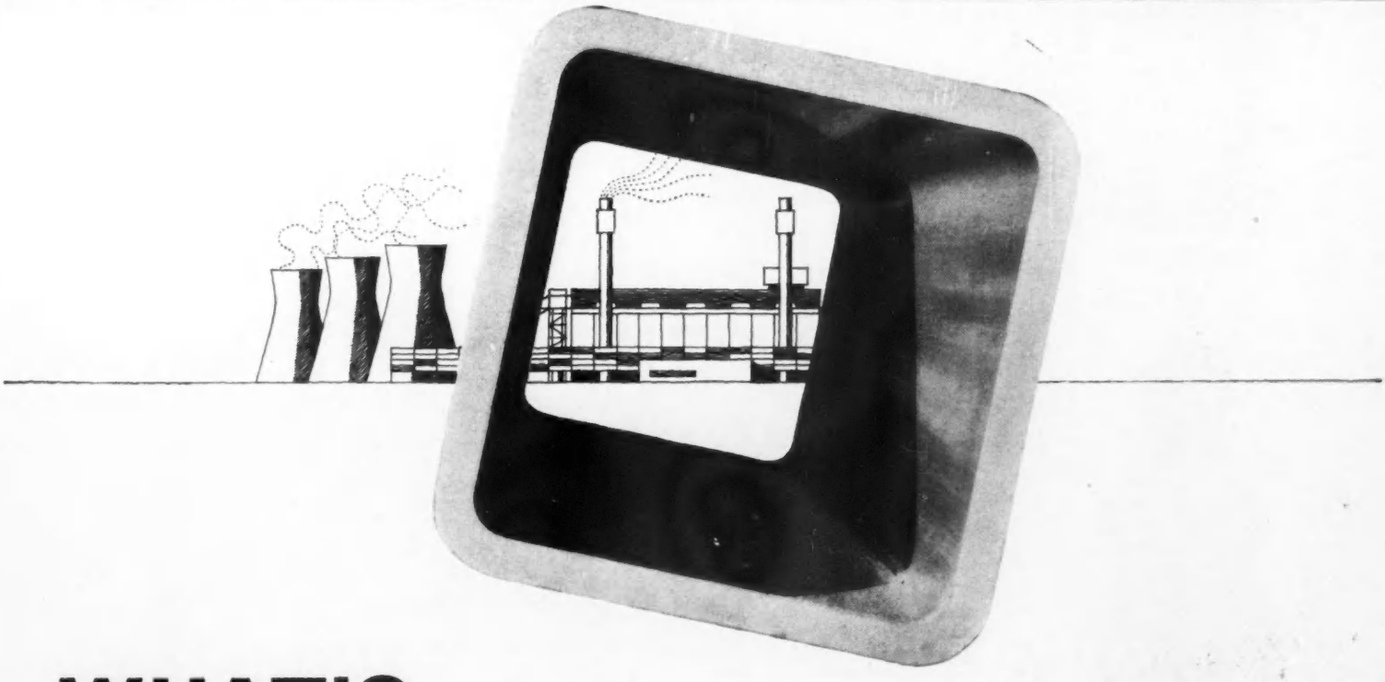

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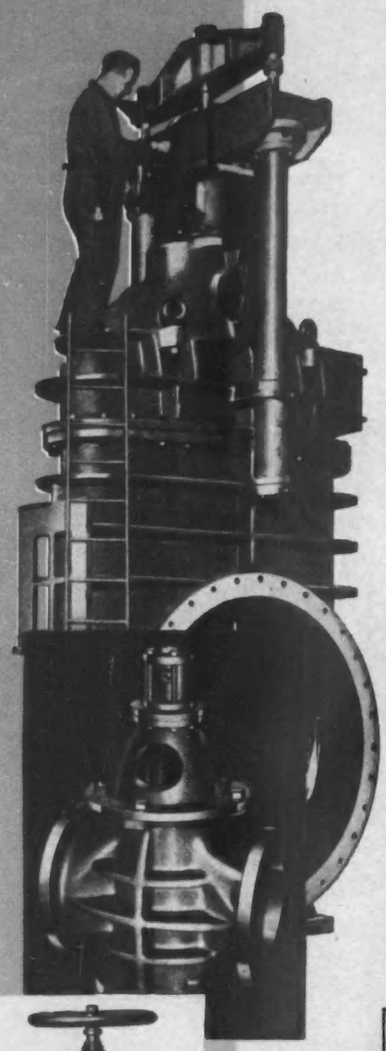

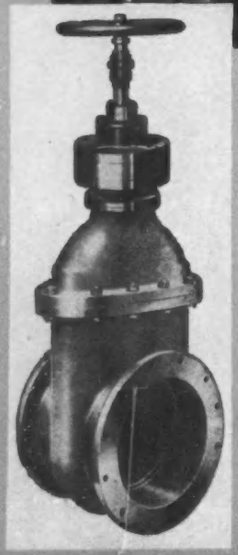

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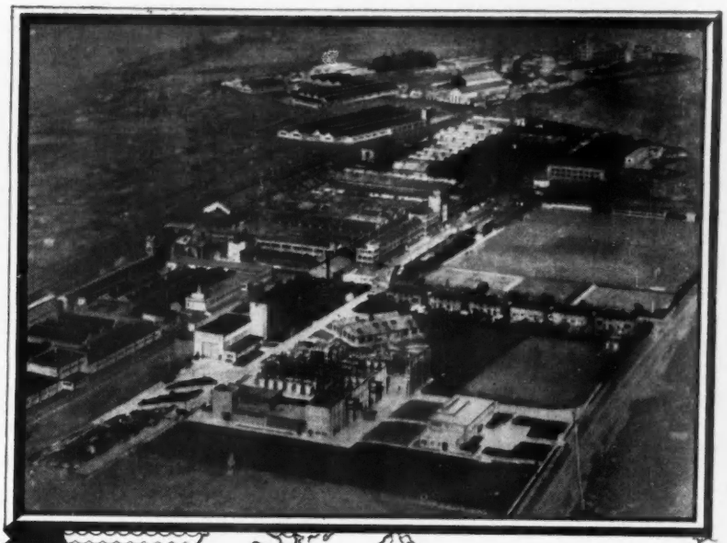

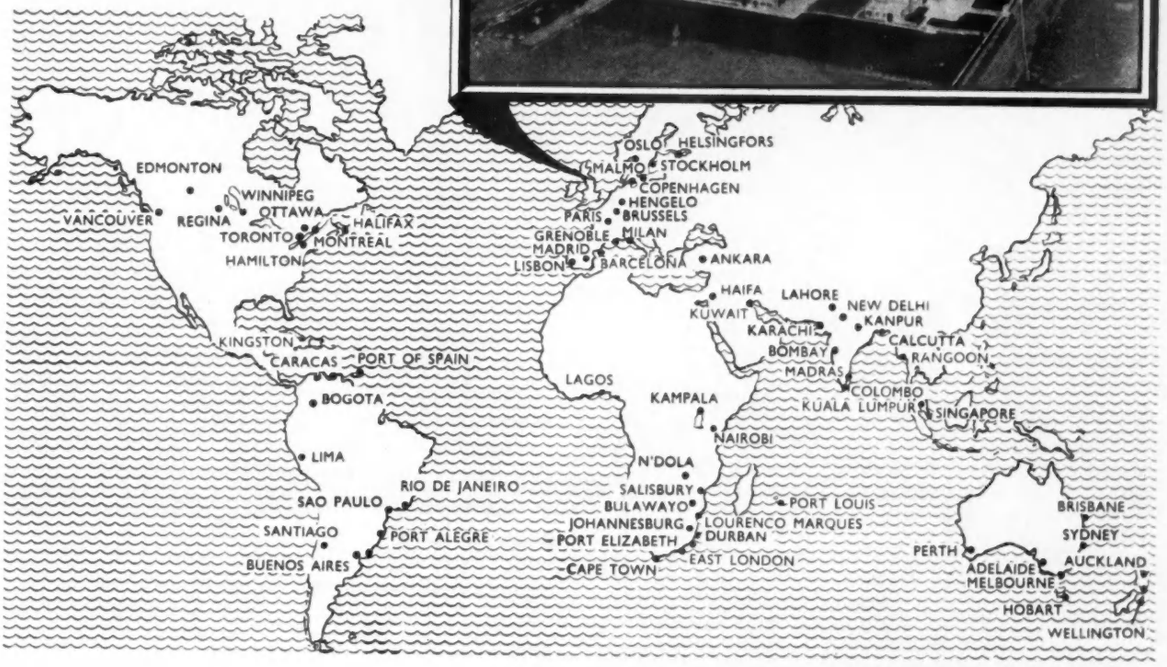

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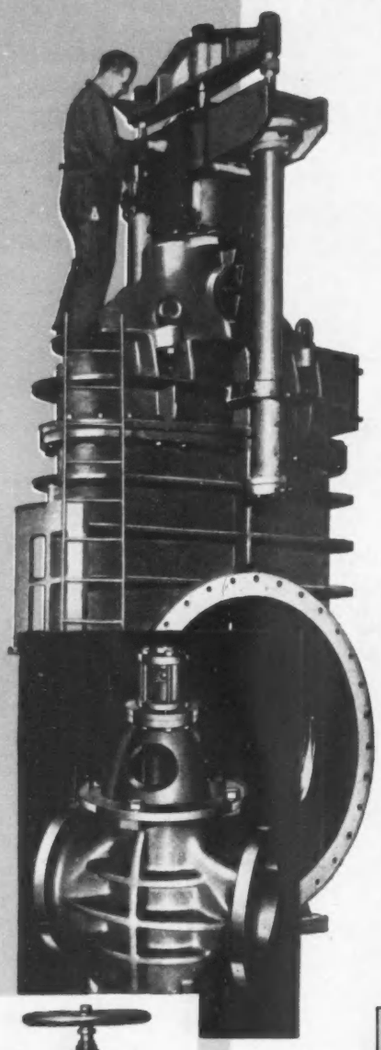

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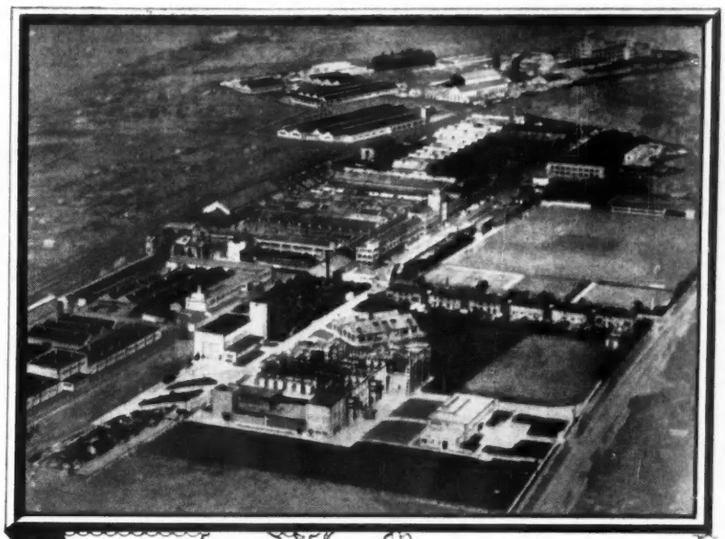

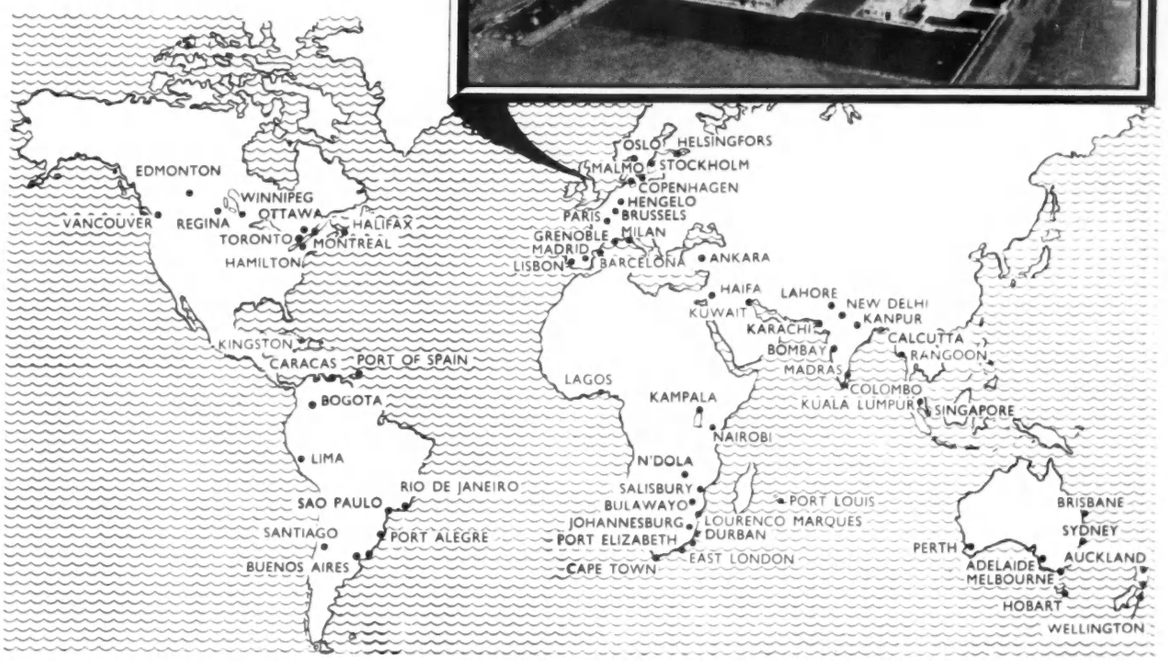

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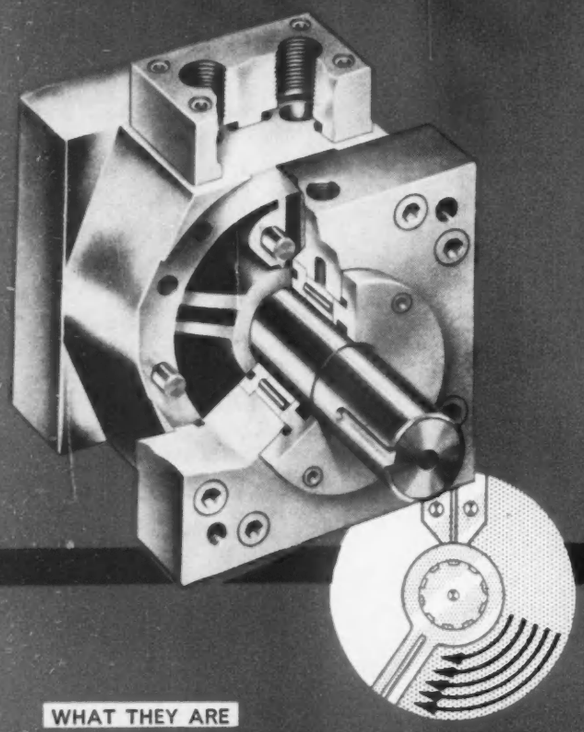

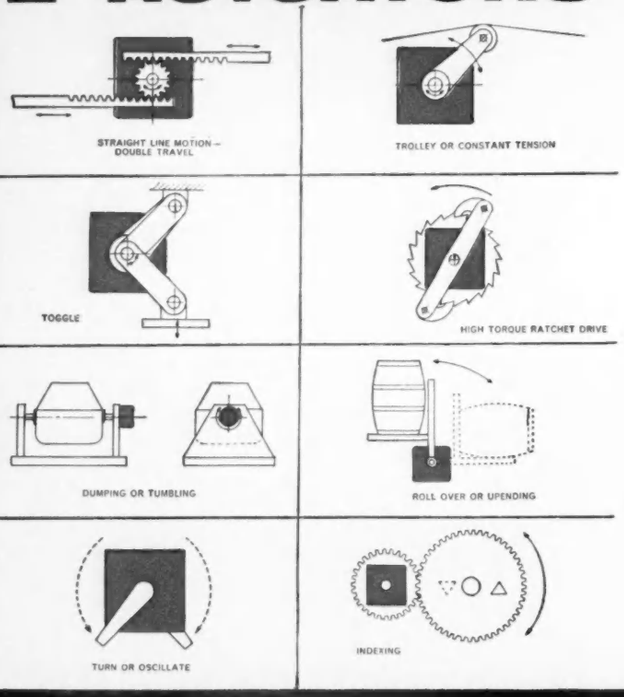

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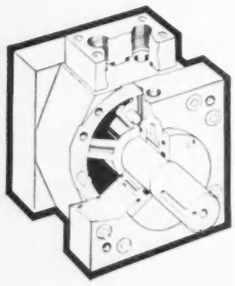

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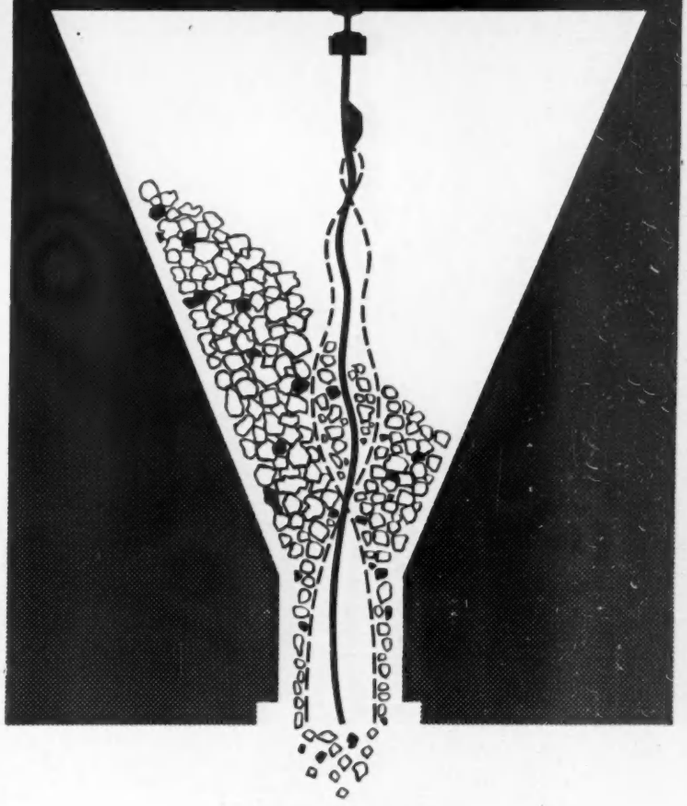

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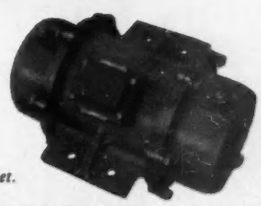

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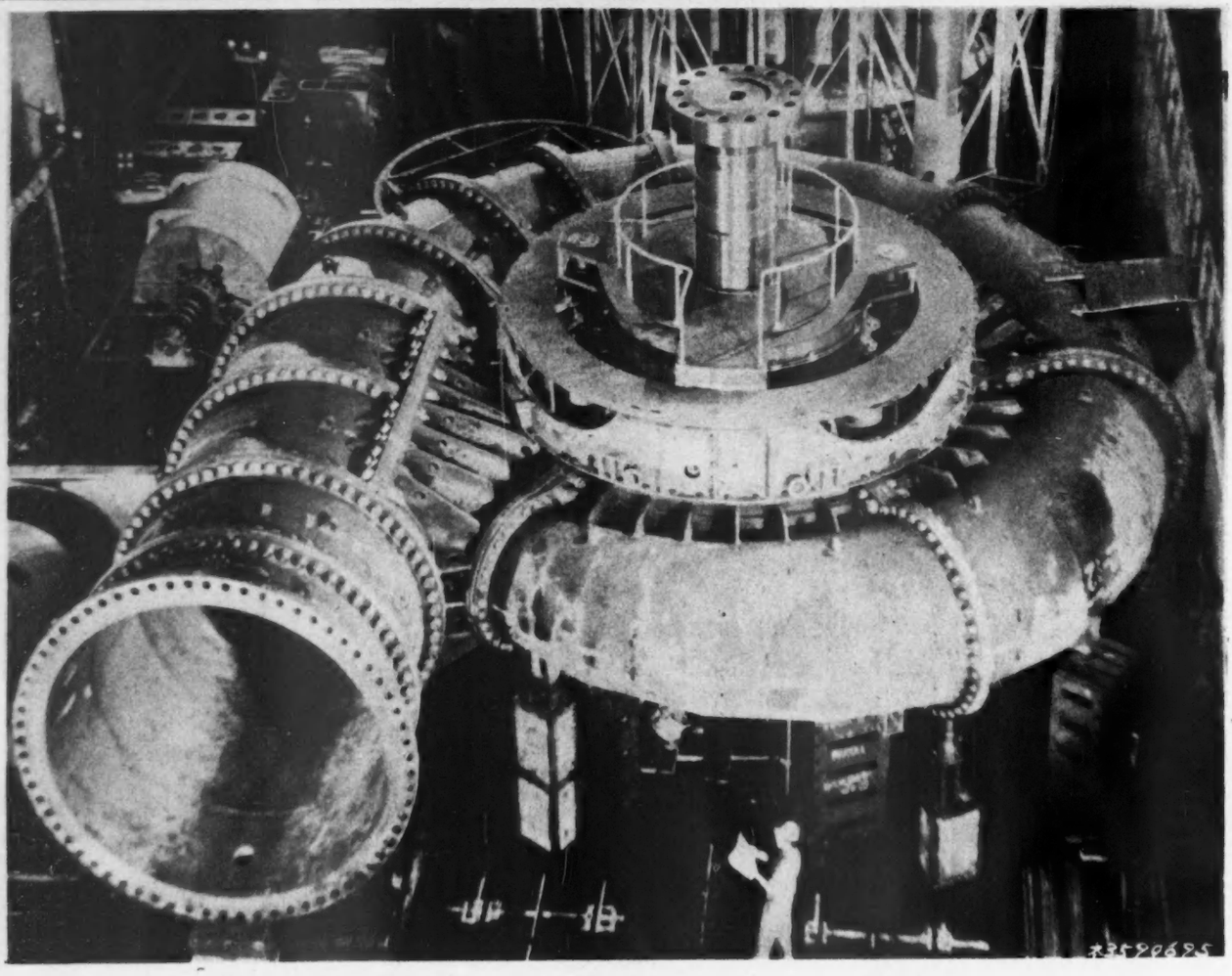
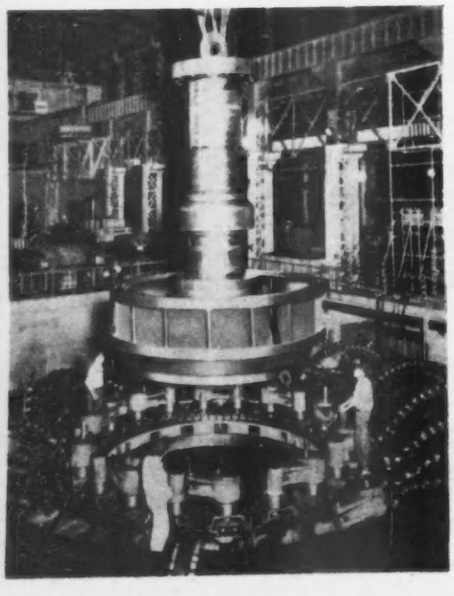


Another big Francis Turbine by Hitachi



The completion of yet another big Hitachi job was recently marked by the successful factory tests of a 137,500 kW Francis Turbine. This is the first of a pair to be built, together with two 125,000 kVA generators for the Miboro Power Station in Central Japan.

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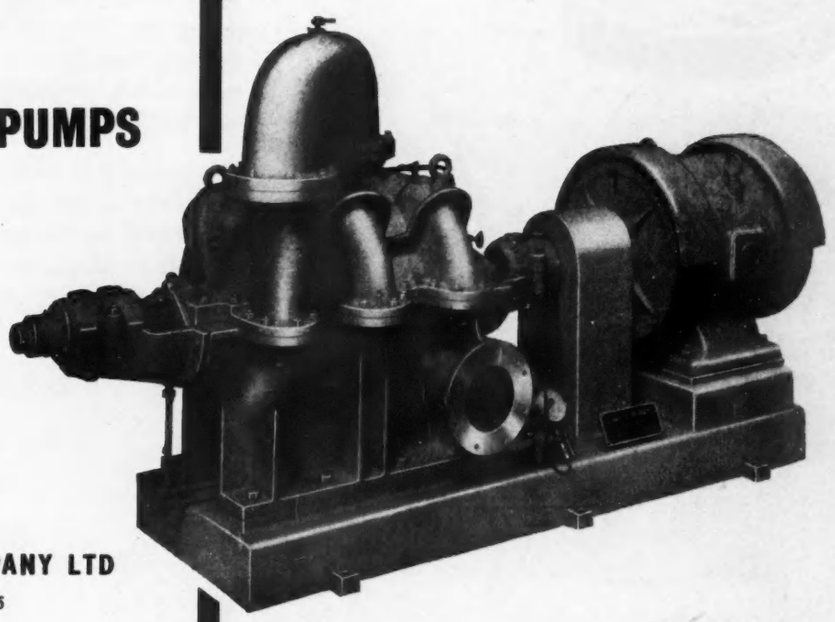

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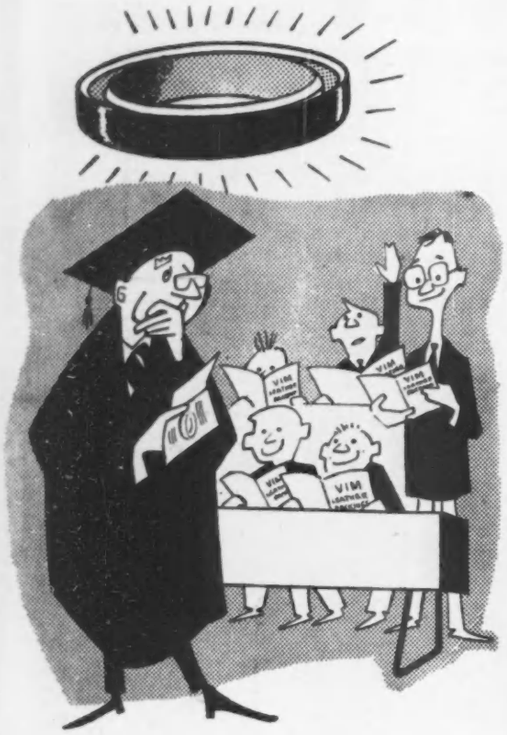

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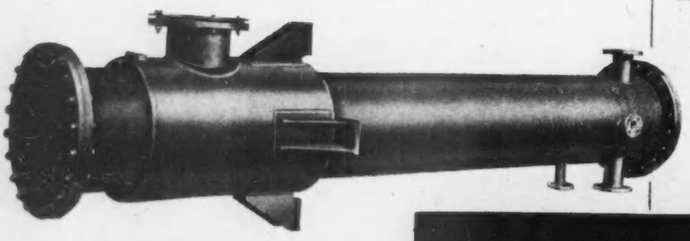

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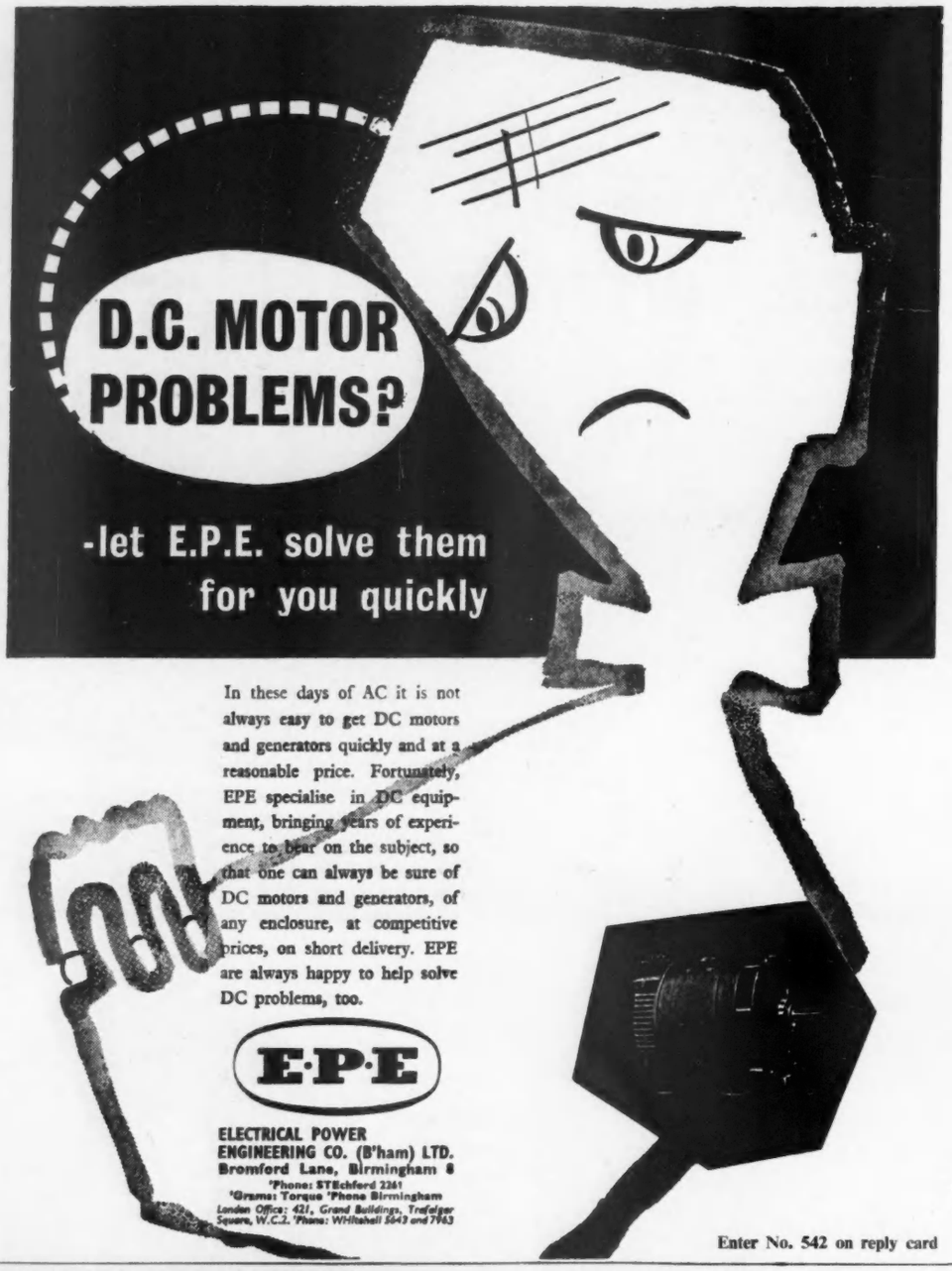

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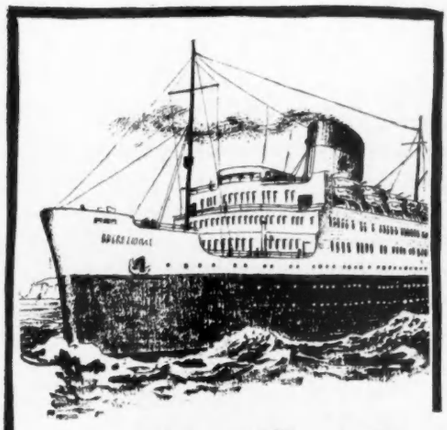
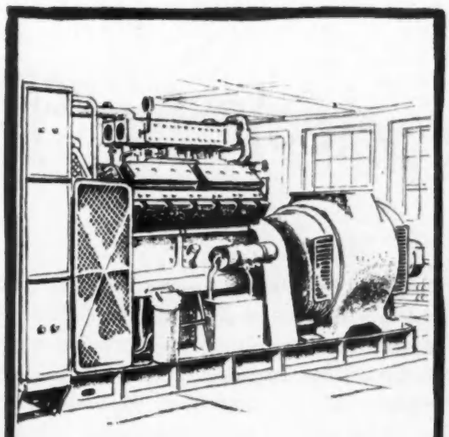
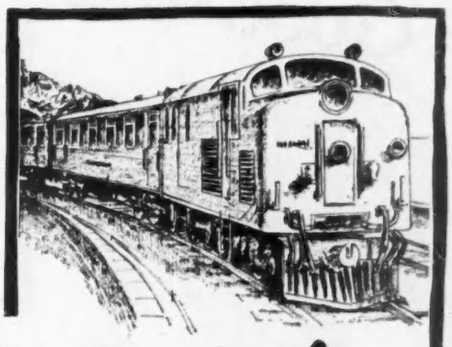
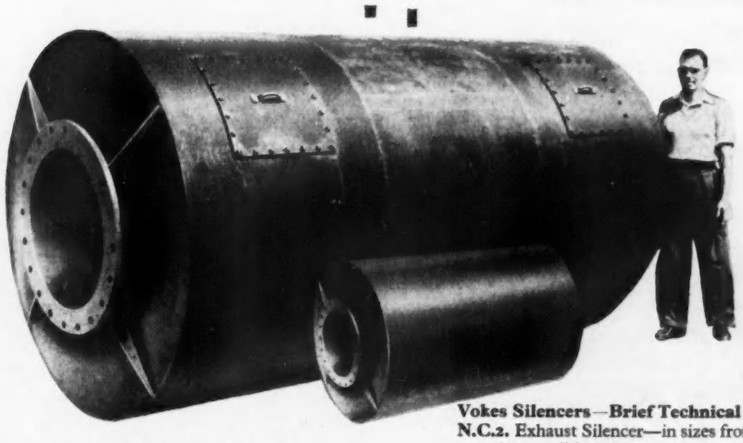






ssssssshhh!



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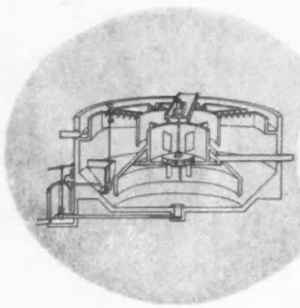

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THE ENGINEER

No. 5426 JANUARY 22, 1960 VOL. 209

RAILWAY WAGES

In the autumn of 1958, the British Transport Commission appointed an independent three-man committee to make a full and detailed examination of the railway wage and salary structure. The committee, of which Mr. C. W. Guillebaud is the chairman, has now been engaged in its task for sixteen months or so but its report is not likely to be presented to the Commission until some time in April. The appointment of the committee followed the last railway pay award, which became effective on June 30, 1958, and which was virtually a 3 per cent increase on existing rates. That award came after many months of negotiation and its acceptance implied the railway unions' support of various measures designed to strengthen the British Transport Commission's finances. Since then, two of the railway unions have made no further wage claim, the inference being that they are willing to await the Guillebaud committee's report. But the third railway union, the National Union of Railwaymen, has for some months been pressing a claim for a substantial increase in the wages of its members. In the stages of negotiation through which the claim has so far passed, it has been rejected by the British Transport Commission. This has led to a threat by some N.U.R. branches in the London district to stage a one-day strike on February 1, an action which is not supported at the union's headquarters. Last week, the British Transport Commission, without making any mention of this threatened one-day stoppage in the London area, announced that, subject to the nature of the forthcoming report, it would be prepared, immediately the report was received, "to discuss with the unions what interim action could justifiably be taken." Furthermore, the Commission promised to back-date any such "interim action" to January 11. It would seem, however, that those N.U.R. branches which have already voiced their impatience are not deeply impressed by the Commission's statement. Nor, evidently, is the N.U.R. executive, for we learn, as we go to press, that it has decided to ask the Commission for an immediate interim pay rise. On top of this, the three railway unions have presented claims for a shorter working week. The National Union of Railwaymen and the Associated Society of Locomotive Engineers and Firemen are asking for a forty-hour week and the Transport Salaried Staffs Association wants a thirty-eight-hour week instead of the forty-two hours at present worked by its members. The British Transport Commission estimates that it would cost £30,000,000 a year to meet these claims in full.

The labour problems which trouble British Railways at the moment are many. Railway wages are undeniably low in comparison with those paid in several other industries and there does not appear to be much incentive to attract men of the right calibre to a transport service which, for one reason or another, has fallen below the high standard of former days. Indeed, ominously, there appears to be some evidence that skilled men, even after years of railway service, are being attracted away from railways into other industries. In the view of much of the public which they exist to serve, therefore, British Railways seem to be floundering in a slough of despond from which they are not very likely to emerge satisfactorily until the modernisation plan is nearer completion. The extensive engineering works called for by that plan are making good progress and by the middle 'sixties British Railways confidently expect to be in first-class condition to provide speedy and really efficient freight and passenger services. But the mid-sixties seem to railway employees and to the public far off; and while the work of modernisation continues, the difficulties of efficient and economic operation are not likely to diminish. Nor are they likely to be diminished if there is a drift of skilled men away from railway service. This interim period between the old and the advent of the new British Railways is one, therefore, in which the financial pressure must be expected to be most acute. During this period the railways are not likely to "break even" financially, let alone show a surplus. Thus, there may well be a case to be made for some form of national assistance! A convenient and helpful method might be for the Government to take responsibility for deficits already incurred and to be incurred by British Railways until the modernisation plan is complete. The excuse for adopting such a policy would be that modernisation was held back by the unwillingness of post-war governments to permit the expenditure of so much capital. The price paid for the delay is incurred in deficits now. Such a course might not receive very cordial approval if only because it smacks of subsidy which nobody, not even British Railways, would really welcome. But, obviously, some fresh attempt needs to be made now to strengthen the railways financially during their time of re-creation so that wage negotiations are not bogged down by financial stringency and skilled employees lost to the service. In seeking eventual financial solvency many matters are, of course, involved besides the improvement of rolling stock, signalling and other technical things included in the modernisation plan. The speedier abandonment of unremunerative branch lines, for example, and a more ruthless determination to be rid of unprofitable transactions of any kind seem to be called for. The business of re-creating British Railways may yet demand more ruthless action on the part of the British Transport Commission and all its staff than has so far been evident. In its last annual report, the Commission pointed out that "if public transport is to provide still higher standards of convenience and efficiency for its users, the morale and keenness of the staff must be correspondingly high; good internal relations must march with the modernisation of the equipment they use." The closest co-operation between the Commission and all grades of its railway staff is now, more

than ever before, positively essential to the survival of British Railways. But it does not seem to us that it can be achieved under existing conditions of financial stringency.

FIRE PROTECTION FOR STRUCTURAL STEEL

The traditional way of protecting structural steel building frames from the possibility of immediate damage by fire, is to encase the steel members in concrete. The concrete must often be 2in thick and reinforced. This expensive, messy and time-consuming process of encasing the steel has been like a sore thumb to designers for years. Some improvement was made by recent changes in the British Standards for design—which allowed, amongst other things, composite action in columns, i.e. the concrete around the column was given a structural function as well as a protective one. But the deadweight of the fire protection of beams remained. The system described on page 143 of this issue, which utilises a lightweight plaster made of gypsum and vermiculite, is a promising alternative, and it seems that this approach to the fire protection of structural steel (a somewhat similar method was described only last week in this journal on page 103, and doubtless other variants are possible) will supersede the concrete casing.

The direct saving in cost offered by the lightweight vermiculite/gypsum casing is worth while. According to Mr. Mackay (whose paper on this subject was discussed yesterday at the " Structurals "), evaluation of a typical ten-storey building design showed a combined saving of about 8 per cent on the cost of the structural frame and foundation together, when the new system of fire protection replaced the usual concrete casing. The biggest saving was, in fact, in the foundation, due to the reduction in weight. This comparison was based on B.S. 449 : 1948 ; using the 1958 standard and retaining concrete around the columns but, of course, with provision for composite action in the design, a saving of 15 per cent was estimated. These figures were carefully worked out, to give an accurate comparison in every way.

The most striking result is clearly that by this change, structural steel is restored to a fully competitive position with reinforced concrete for building frames. Over the last few years it has been generally accepted that r.c. frames are 15 to 20 per cent cheaper than structural steel. The changes in B.S.S. 449 and the introduction of " Universal " sections have helped to restore the balance. Now, apart from the direct saving, estimated at 15 per cent in one typical case, as we have just quoted, there are other advantages, outlined by Mr. Mackay as follows : " The cost is accounted for, not only by the labour and materials which go into the casings ; it is also due to the contract time consumed in the process of forming them. It is not uncommon for three or four storeys in a modern tall building to be neutralised for any other trade owing to the presence of props or the erection or striking of formwork from the sides and soffits of beam casings. The introduction of vermiculite/gypsum plaster on metal lathing leads to a fundamental change in the building programme. The task of forming fire protection is transferred from the carpenter, the steel fixer and the concreter, working in the open, to the plasterer working inside a weathertight building. If the process of forming thousands of lineal feet of concrete beam casing can be eliminated, the interval between completing the steelwork and asphalting the roof can be substantially reduced ; and for the same reason the other trades can all follow up more promptly. It is true that a substantial amount of metal lathing has to be fixed as a base for the plaster but the increase in the amount of actual plastering work is very small indeed. The analysis of cost described did not attempt to evaluate these factors, although they must reflect to the credit of lightweight fire protection." It will be interesting to see what new developments emerge to reduce the cost of multi-storey frames, in either material, still further. We have commented in the past on the illogicality of the concrete encasement, but then the r.c. frame was not a serious competitor until recent years. There was nothing to challenge the steel structure for multi-storey buildings and it needed the spur of competition to bring about technical improvement. Other improvements are still feasible to reduce the cost of steel-framed buildings even more—for instance, the introduction of a composite steel floor slab and, doubtless, the r.c. frame has not reached finality. If no decisive cost advantage is gained by either material, we may expect to see some such measures introduced. It is clearly the competition between them which is proving of broad benefit.

COAL PROSPECTS

Just after our last issue had gone to press, Sir James Bowman, chairman of the National Coal Board, made his customary statement about the activities of the coal industry over the past twelve months and its prospects for the current year. Most of the figures included in the statement are well known. Briefly, they are that in 1959 this country's coal output amounted to 206,000,000 tons (9,000,000 tons less than in 1958), home consumption was 190,500,000 tons (12,000,000 tons less than in 1958) and export and overseas bunker requirements were 4,300,000 tons. This state of affairs inevitably meant further additions to the undistributed coal stocks which, by the end of the year, totalled 36,000,000 tons. By putting so much coal to stock, however, the Board claims that it has been able to meet the first shock of the fall in demand, though it has been an expensive exercise. The last time the coal industry suffered a fall in the demand for its products, similar to that which it is now experiencing, was between 1929 and 1932. At the end of that period, 350,000 miners were unemployed and most of those who remained in the industry were working short time. The more recent problem created by the declining demand over the last two or three years has been tackled differently. Since the end of 1957, the coal-mining labour force has been reduced by 70,000, mainly by allowing normal wastage to outrun recruitment, with the result that by the end of last year only 1300 men under the age of sixty-five were still unplaced in other jobs.

But although the Coal Board has succeeded in reducing its manpower without causing extreme hardship to the mining community, there are other problems which it must endeavour to solve satisfactorily. Industrial production is rising again and, despite fierce competition from oil, coal requirements in the coming months may reasonably be expected to be higher than in the last two years or so. But how much higher, it is difficult to forecast. In the present year, the Board reckons that home consumption may reach 196,000,000 tons, which is about 6,000,000 tons more than in 1959. That consumption estimate, however, is below last year's production figure. The Board, therefore, intends to reduce output by a further cut of 4,000,000 tons in opencast production and by the closing of about forty-six collieries, most of which are reaching the end of their workable reserves. The reduction in this year's output caused by these closures and the full effect of the pit closures carried

out in 1959 is assessed at between 4,000,000 and 5,000,000 tons. By these steps, it is hoped to bring output into line with current demand and there is the underlying hope that the demand may strengthen sufficiently for a start to be made on the running down of the undistributed stocks. Most of the stock consists of untreated small coal for which, the Board claims, there is a large and growing demand.

In his statement last week, Sir James Bowman made no attempt to gloss over the difficulties which the coal industry is striving to overcome. Although the accounts for 1959 are not yet available, it is known that a deficit was incurred wholly because of the costs and provisions of coal stocking. The Board's total capital expenditure last year was of the order of £108,000,000 and there were in progress no less than 146 schemes for new collieries and drift mines or for the reconstruction of existing collieries. Perhaps the most heartening part of Sir James Bowman's statement was that dealing with the industry's improving efficiency. In 1959, output per manshift was 6 per cent higher at the face and 5·3 per cent overall than in the preceding year and was, in fact, the biggest increase recorded for over thirty years. Consequently, production costs last year were about 1s. 9d. a ton lower than in 1958, although as Sir James said, " the burden of overheads was higher because of reduced outputs." Sir James recognises that, compared with its rivals, coal is an old industry but it is not at all unreasonable to add that the progress in efficiency achieved in 1959 is practical evidence of its " vigour and vitality." That vigour may well be rewarded for the coming months may reveal after all that the demand for coal is rising rather more quickly than is at present envisaged.

COST OF SPACE RESEARCH

Elsewhere in this issue we reproduce part of a lecture delivered about a fortnight ago to the Wolverhampton and District Engineering Society by Mr. E. G. D. Andrews, chief designer, rocket division, Bristol Siddeley Engines. Mr. Andrews criticises the Advisory Council on Scientific Policy for its attitude to space research. So did we in a leading article published in our issue of December 25. For ourselves, we felt forced at that time to accept the Council's conclusion that, operating alone, this country could not find the financial means to make any notable contribution to the rocket building side of space research. We therefore suggested that if the recent agreement with the Americans to place British satellites in orbit through the use of American rockets could not be extended to permit British rocket engineers to participate in the design of suitable rockets, then Britain should seek to collaborate with Western European countries in that field. We still think there would be value in such collaboration. But Mr. Andrews feels that it should be possible for Britain to go it alone if that collaboration cannot be arranged. For he thinks the Council's recommendations were " highly contentious." He quotes the Council's finding—now, we suppose, handed down to the recently-formed British National Committee on Space Research—that " the cost of venturing into space with lunar, planetary, or solar probes would be too great for our resources and, because we do not think that the scientific and technological return to be expected is likely to be commensurate with the cost, we have not recommended any British participation in these activities at the present time, nor in the attempt to launch human beings into space." First, Mr. Andrews contends, the Council, after reaching a conclusion that the results of a design study are needed before a decision can be reached, proceeds to condemn out of hand and without benefit of the design study any more ambitious programme than the very modest one it suggests. Secondly, he thinks the Council greatly over-estimates the cost, presumably by assuming that it must be of the same order as that of the programmes in which the Russians and the Americans are indulging. By contrast Mr. Andrews reaches the conclusion that a space research programme based on the development of a " Blue Streak–Black Knight " combination, capable of putting a 1000 lb payload into orbit at a distance of 300 miles, or of launching lunar, planetary, or solar probes of 50 lb to 100 lb payloads, would cost only about £1,000,000 in the first year, rising each year by about £1,000,000 and eventually levelling off at £5,000,000 to £6,000,000 a year. If it kept British rocket engineers in the forefront of design and research in the rocket engineering field that sounds to us a modest enough expenditure. Of course some critics are sure to claim that at such a low cost Britain would merely be able to follow where the Russians and the Americans had already led. But as long as so very much secrecy is maintained in the rocket engineering field no one can feel sure upon that point ; and for our part we have a lot of faith in the abilities of British engineers to make substantial contributions to new knowledge of and practical design of rockets.

The Engineer—100 Years Ago (JANUARY 20, 1860)

" INSTITUTION OF NAVAL ARCHITECTS "

" This institution has been in course of formation for several months past, during which period it has obtained the support of many eminent persons . . . The managing council of the institution consists exclusively of professional gentlemen, and comprises the master shipwrights of all her Majesty's dockyards and several of their assistants. With the council are connected Mr. Joseph Maudslay, Mr. J. Macgregor of the Temple, Sir W. Armstrong, Captain E. P. Halstead, R.N., and Captains Sullivan and Walker, of the Board of Trade. Mr. E. J. Reed has been elected secretary.

" The objects of the Institution of Naval Architects are wholly comprised under three heads :—First, the bringing together of those results of experience which so many shipbuilders, marine engineers, naval officers, yachtsmen, and others are acquiring quite independently of each other in various parts of the country, and which, though almost valueless while unconnected, will doubtless tend much to improve our navies when brought together in the printed transactions of the institution. Secondly, the carrying out by the collective agency of the institution of such experimental and other inquiries as may be deemed essential to the promotion of the science and art of shipbuilding, but are of too great magnitude for private persons to undertake individually. Thirdly, the examination of new inventions, and the investigation of those professional questions which often arise and are left undecided because no public body to which professional reference can be made now exists."

Recent Mechanical Engineering Development in Automatic Control

(Contributed)

A SYMPOSIUM on Mechanical Engineering Developments in Automatic Control was held at the Institution of Mechanical Engineers from January 5 to 7, 1960. Thirteen years have now passed since the Institution of Electrical Engineers organised a conference in 1947, which practically introduced servomechanism technology to the uninitiated. Since then there has been the Cranfield conference of 1951, and the "Mechanicals'" conference on hydraulic servos in 1953. Subsequently, the scope of automatic control has become so vast that the decision to limit the scope of the recent Symposium to the field of mechanical engineering was no doubt the only way of saving the participants from severe mental indigestion.

If the Symposium has not shed any blinding light on our problems, the fault is neither with the organisers nor with the authors of the papers. The simple truth is that both the basic principles and the essential components of auto-control systems are by now well established, and little that is exciting can be said on either at the present stage.

Perhaps the one fundamental new topic is that of "adaptive" controls, and this was mentioned in Dr. Hrones's James Clayton Lecture. An interesting new kind of component (new, that is, in the present context) was described by Mr. Scher of M.I.T. (more of this later). Much valuable detailed work and experience accumulated at the Royal Aircraft Establishment and the Admiralty has been made public as a result of this Symposium. For the rest, we have been given extensions of knowledge into several detailed but by no means important topics, and examples of elegant if not revolutionary (and who wants a revolution when all is going well ?) solutions to application problems.

For all this, we must be grateful to the Institution, to the Symposium Organising Committee, and to its chairman, and moving spirit, Mr. H. G. Conway.

The Symposium was attended by some 700 delegates, and was opened by the delivery of the James Clayton Lecture, "On Automatic Control," given by Dr. Hrones, Vice-President of the Case Institute of Technology. Besides this, the Symposium included five papers by American authors, including three from the Massachusetts Institute of Technology. The M.I.T. delegation included Dr. S. Y. Lee, who has been responsible for some of the more notable advances in the understanding and development of hydraulic servo devices, and who took part in the discussion. The remaining contribution from overseas was the paper by M. Bézier of Renault.

James Clayton Lecture

The bulk of Dr. Hrones's lecture consisted in a review of the basic theory of automatic control, including its historical origins. There was a brief discussion of one recent development, namely, "adaptive" controls, which are being developed for aircraft and missile auto-pilots, but obviously have potentialities far beyond this field. To be effective over an appreciable speed range, an auto-pilot must vary its "gain" (say the elevator angle applied per degree change of aircraft pitch attitude) as the aircraft speed changes, since otherwise its action would be too weak at low speeds and too strong (leading to instability) at high speeds. Present auto-pilots do this in response to speed-sensitive devices. By contrast, adaptive auto-pilots make no use of data directly relating to the environment, and function by applying test inputs to the aircraft and to a "model" (usually an electrical circuit) which has the desired response, which is fixed. Responses of aircraft and model are compared, and the gain is adjusted according to their difference. Parameters other than direct gain may also be involved. Dr. Hrones concluded with some remarks on the educational problems being posed by the advent of automatic control on a large scale, and the efforts now being made to break down the barriers between the traditional categories of engineering.

Automation in Manufacture

Of the seventeen papers presented, all but two related more or less directly to servo problems. One of these two was the already-mentioned paper by M. Bézier, who described automation processes in the manufacture of the "Dauphine" motor-car. The account was impressive, even though the techniques are familiar to those acquainted with transfer lines in the motor industry, and some interesting statistics on the achievements of automation were included. An interesting sidelight is that "... the hourly cost of depreciation (of the machines) is well above the direct labour cost of the operators. The economy that can be effected by the reduction in the cost of the machines ... is greater than would be expected from the reduction in the cost of direct labour ..." Thus do we go full circle, and labour becomes (relatively) cheap again. M. Bézier's paper was followed by an excellent film illustrating manufacture of "Dauphine" cylinder blocks.

In the discussion, M. Bézier neatly described the transfer line as "the materialisation of the process chart," and thus by its very nature unsuitable for manufacture of anything but very large quantities—it was far too inflexible. He was also doubtful about the economics of tape-controlled machines for anything but prototype work.

Of a similar nature was the paper by Mr. Stuchbery, of the Metal Box Company, on the manufacture of food cans. This, too, was a lucid account, with some interesting economic facts, and was followed by a film. To most of the engineers present, it must have appeared as an interesting glimpse into an unfamiliar world, rather than a contribution to their directly usable knowledge.

Hydraulic and Pneumatic Servos

No less than eight of the remaining papers were directly concerned with problems arising from, or devices used in, hydraulic (or in one instance, pneumatic) servos, while hydraulic servo devices played some part in four further papers. Two papers dealt with a fundamental subject, namely, flow through servo valve orifices. One of these, by Professor Shearer of M.I.T., was a summary of available knowledge, including some material from Russia, and results of recent work in the U.S.A. The general impression was that much still remains to be learnt. The paper by Professor MacLellan, Mr. Mitchell and Dr. Turnbull, described research which these workers had carried out at Cambridge on flow phenomena in valves, including some of the effects of the configurations of the chambers into which the flow was directed. The most important finding is that there are two basic flow patterns, in which respectively the flow does or does not become attached to one of the walls of the outlet chamber. (Professor Shearer's paper mentioned a similar phenomenon in nozzle valves.) The type of flow depends on valve opening and other parameters, and under some conditions both types are stable, which could in principle lead to difficulties, since different discharge coefficients apply to the two cases. The paper also mentioned a method developed by the authors for reducing Bernoulli forces in valves, which is certainly much cheaper than any other proposed so far. As pointed out by Dr. Williams, however, this method does not reduce the initial force-displacement gradient, which is a cause of servo instability in some cases.

In the discussion, the point was made that most of the fundamental research work was applicable to annular or rectangular orifices, whereas round orifices were used in a large proportion of hydraulic servo valves. A member of the British Hydromechanics Research Association stated that its work has shown that flow is turbulent at pressure drops greater than 2 lb per square inch, with a possible implication apparently that the danger of bi-stable flow patterns could be discounted.

Judging by the discussion, particular interest was aroused by the paper by Mr. Eynon, who described work done on hydraulic servos at the Royal Aircraft Establishment, and thus made publicly available the fruits of many years' work in developing practical electro-hydraulic servo valves. Mr. Eynon described the reduction of valve stiction forces by reducing land areas, and the reduction of Bernoulli forces by using the basic techniques developed at the M.I.T., but in somewhat simplified form, and included extensive data on valve shapes required to achieve desired force levels. Manufacturing techniques were also discussed in some detail. Mr. Eynon also discussed the matching of the torque motor to the valve, and the effect of Bernoulli forces on servo performance. Generally, this is to reduce the sensitivity of flow to load, which leads to instability if the load is predominantly inertial, but which in other cases may be used to good effect. A two-stage servo valve developed at the R.A.E. was also described, although Mr. Eynon thought that single-stage servos were feasible up to 30 h.p. On this point, Dr. Lee of M.I.T. commented that he had reached the conclusion that 3 h.p to. 4 h.p. was a desirable upper limit, but that single-stage operation at higher powers should be worth while in "one shot" missile systems, where economy in fluid was a major consideration. Mr. Eynon also discussed problems in the use of compressed gas servo-actuators.

There was much discussion on production difficulties in the manufacture of servo valves. Mr. Eynon mentioned that valves with clearances down to 0·00005in were now being used, but that he regarded 0·0001in to 0·0002in as the minimum which was safe from the point of view of silting up, and he thought that this figure was relatively easy to meet. Mr. Conway thought that production problems were such that it was difficult to make servo valves for less than £50, but Dr. Lee said that figures of 50 dollars were now being achieved in the U.S.A.

Dr. Williams, of Hendon Technical College, presented a paper on the effect of oil momentum forces on hydraulic servos. This may be the first, or one of the first, publications on this subject, but the phenomena concerned were not unknown to workers in the hydraulic servo field. Bernoulli forces acting on a servo valve vary with flow for a given valve opening ; the higher the load the less the flow, and hence the less the Bernoulli force. If the valve is driven by a torque motor of finite stiffness, increase in load results in increase in valve opening, and hence in reduced (and possibly even negative) sensitivity of flow to load. If the load is predominantly inertial, this leads to servo instability.

Mr. Glaze, of H. M. Hobson, presented a paper on the use of analogue techniques in the analysis of hydraulic jack servos. Factors considered are load inertia, elasticity and damping between jack and load (" outside the loop "), and elasticity and damping at jack attachment. Solid friction at the jack is taken into account, and it is in this respect that Mr. Glaze had to offer a really interesting finding (which some of us had suspected but never established before), namely that jack friction can account for the fact that simple jack servos are stable in spite of contrary predictions based on a simplified analysis in which friction is left out of account. Transient pressures well above the supply pressure were measured (or rather computed) under certain conditions, as predicted by some previous workers.

The last, and in many ways the most interesting, of what might be termed the " basic " papers was one by Mr. Scher, of M.I.T. The title is " Development of a Gas-operated Reaction-jet Servo-motor," which, as the author points out in his introduction, is a special adaptation of Hero's turbine. It consists of a pair of radial arms on a rotating shaft, which is fed with high-pressure gas which escapes from one circumferentially directed nozzle at the end of each arm. Astonishing power to weight ratios can be achieved, and a further attraction is the possibility of operation at high temperatures, if bearing problems can be solved. A complete theoretical analysis is presented, though certain data are very imperfectly known, particularly those relating to windage losses. Experimental results show outputs well below the predicted values, though still very well worth while. However, it is early days.

Electro-Hydraulic Servos

Mr. Garnjost, of Moog Servocontrols, presented a paper which described the design of an electro-hydraulic servo-actuator in which, in order to save complication and wiring, feedback was obtained by converting actuator movement to force through a spring, and applying the spring load to the torque motor driving the valve. Pressure feedback was required to stabilise the servo, but this had to be a transient feedback to prevent an increase in the low-frequency output compliance of the servo. The transient feedback is achieved by a hydraulic resistance-capacity network, which is described in detail. Square law orifices are used, and an attempt to make the characteristics linear is described, though this was finally rejected, since stability at low amplitudes was found to be adequately ensured by jack friction. The paper is an excellent example of an unpretentious exposition of problems encountered in a practical design exercise.

Messrs. Sung and Watanabe of Bendix presented the analysis of an electro-hydraulic servo system with various elasticities and masses, and other sources of lag, taken into account. The analysis is linearised, with the help of " describing function " technique to deal with non-linear effects, and the overall system was studied on a computer. Some experimental response measurements are also presented. Some discussion is devoted to the use of high-speed hydraulic motors instead of jacks ; this can be beneficial in that it results in decoupling the elasticity present outside the loop, i.e. between the jack and load, due to the relatively high effective inertia of the motors and the high stiffness of the oil volume, as compared with jacks.

Mr. Sung made an intriguing reference to methods of reducing oil elasticity in jacks. This was explained during the discussion by Dr. Royle of Manchester University, who had been engaged on this work, and who described two solutions, intended for machine tools requiring a long stroke. In the first, two short stroke jacks were employed. At any one instant, one jack was driving the machine slide, while the other had its body unclamped from the machine bed and was stroked back to its starting position—there is, of course, an overlap period in which both jacks are driving, to ensure continuity. In the second and perhaps neater solution, the jack body was carried on a lead screw driven by an electric motor ; the latter need only be a very crude kind of servo, since accuracy and high response was ensured by the jack, which again had only a very short stroke.

Moving further towards the field of specialised applications, Messrs. Summerlin and Towner, of the Sperry Gyroscope Company, Ltd., described a two-dimensional electro-hydraulic copying system, built up from standard servo components. The system uses a rotatable sensing head driven by a light electrical servo, and carrying a low-friction sensing head, with electric pick-offs operating in two axes. One of the pick-offs causes the head to rotate until its signal is nulled, while the other provides the copying error signal. This, and the feed signal, are resolved by synchros carried in the head, and the resolved signals are fed to servo jacks operating main and cross slides, resulting in the cutting head being given a " copying " motion normal to the template (until copying error is null) and a " feed " motion tangential to the template. Various refinements are described, and the possibility of extension to three axes is mentioned.

The paper by Mr. Levetus, of Keelavite, opened with some information on the response of relief valves, and went on to describe some purely hydraulic velocity control systems based on a master metering pump driven by a constant speed electric motor, and drawing its supplies from a " follower " metering pump driven by the load. Any discrepancy between the two results in a drop or rise in the pressure in the line between them, and this is used to control the flow from the main pump to the load. The system is obviously very sensitive, and high accuracies are claimed. Extensions to multiple synchronisation problems are described. The system can also be used to set a machine to achieve a predetermined stroke ; in this case the metering pump draws its supply from a jack, which is set at a fixed stroke. An application to a tube-reducing machine is described.

Missile and Gun Control Systems

Messrs. Davies and Law, of the R.A.E., presented a paper on gas turbine driven alternators, their control and protection—the alternators concerned are those used in aircraft and missiles. Various types of alternators suitable for this field were described in principle, and problems dealt with were high temperature operation, speed and voltage regulation, waveform correction, and system protection.

Mr. Tindale, of Elliott Brothers, and Mr. Nicholls, of the Admiralty Surface Weapons Establishment, gave a joint paper describing a recent naval anti-aircraft gun control system. The paper started with a very lucidly presented analysis of essential problems of fire control, and went on to details of the manner in which they had been solved in the equipment in question, the exposition being illustrated with diagrams and perspective drawings of exemplary clarity. The equipment consists of a radar dish mounted on a platform carrying the operator, who controls it through a joystick acting through a gyro-stabilising system and hydraulic training and elevation servos. Training and elevation of the gun are constrained (through servo loops) to follow the training of the platform and the elevation of a " gun-line " gyro mounted thereon, while the radar dish and optical sights follow a " sight-line " gyro. The angle between the two gyros is determined by a computer, consisting as far as practicable of mechanical elements. The gyros are mounted inside power gimbals operated by hydraulic servos, to ensure that precession torques act in the required axes. Basic computer elements are described in diagrammatic form, and some details of hydraulic servo elements are also given.

The reasons for adopting a mechanical analogue computer were explained in another paper, by Mr. Smith, of Elliott Brothers, which also gave constructional details of several of the mechanisms used, such as low friction slides of novel design, resolvers, and other elements. The possibility of using mechanical analogue devices for industrial applications was discussed.

Discussion of these two papers revealed that this equipment was regarded as the last anti-aircraft fire control apparatus to be used by the Royal Navy, since ultimately reliance is is to be placed entirely on guided missiles.

Some More Human Aspects

Professor Sheridan, of M.I.T., presented a paper on the transfer function characteristics of human operators, particularly as affected by fatigue, drowsiness and alarm signals. Responses were measured for a tracking task, the input consisting of the sum of a number of harmonically unrelated sinusoids, enabling an automatically computed Nyquist plot to be directly obtained by a sampling process, and displayed on a cathode-ray tube.

A final, and controversial, paper was presented by Messrs. Lawrence and Powell, of Joseph Lucas (Gas Turbine Equipment), Ltd., entitled " The Role of the Control Specialist in Industry." The authors described —and it may be fair to say advocated—the use of a small group of automatic control specialists acting as consultants to other engineers within the firm, the economic aspects of such a service being discussed in some detail. An example of the way in which such specialists could help was given, which turned out to be the solution of a straightforward linear stability problem involving a second order equation !

Several speakers attacked the paper in very strong language, disagreeing with the basic concept of the specialist control group, and with almost every detail of the whole paper. Under such an onslaught, it was too much to expect Mr. Powell to make a convincing reply on the spur of the moment, and it must be recorded that in the writer's opinion he did not succeed in so doing. It will be interesting to see how the authors will defend their thesis in their written reply.

British Participation in Space Research

ON January 6, 1960, Mr. E. G. D. Andrews delivered a lecture on " Rocket Propulsion for Atmospheric and Space Flight " before the Wolverhampton and District Engineering Society. We print here the final section of the lecture.

This is an appropriate point at which to consider Britain's part in space exploration and research. To some extent, of course, we already have a space research programme. We have launched about twenty " Skylark " solid propellant sounding rockets for research at altitudes up to 100 miles. We have the " Black Knight " programme in which five vehicles have been launched, some of them with instruments for pure research at altitudes up to 500 miles, and others are to follow. We have the Jodrell Bank radio telescope which has been of inestimable value in the American and Russian satellite programmes, and has brought us considerable prestige even though as a nation we did our best to dodge responsibility for paying for it. We have authorised expenditure of between £100,000 and £200,000 a year on research, instruments for which are to be flown in the N.A.S.A. " Scout " satellites, generously made available by the United States Government. Also, the Prime Minister has announced that the Ministry of Aviation has started to prepare design studies of a British satellite launcher based on British missiles. As there are only two British missiles of suitable size for this work—" Blue Streak " and " Black Knight "—and as these are well suited for combination, these will presumably be the basis of the design studies.

So far, Britain's policy has been sensible if perhaps a little tardy. The " Skylark " launchings were part of our contribution to the International Geophysical Year. The " Black Knight " launchings were primarily part of our I.R.B.M. studies. The other parts of our programme were based on the recommendations of the Advisory Council on Scientific Policy. This Council has now handed over its direct contact with space research to the newly-formed British National Committee on Space Research, but in doing so, in its last annual report, it has left them with important guiding principles.

Quite rightly, the Council considers that we could not launch our own satellites for about five years, and it wishes to know the cost of a British satellite launching programme before deciding whether or not to recommend that we proceed with one. About subsequent steps the Council says that " the cost of venturing into space with lunar, planetary or solar probes would be too great for our resources, and because we do not think that the scientific and technological return to be expected is likely to be commensurate with that cost, we have not recommended any British participation in these activities at the present time, nor in the attempt to launch human beings into space." These remarks are highly contentious. Having admitted that the results of a design study were required before a decision could be made on a satellite programme, the Council condemned a more ambitious programme out of hand without benefit of a design study. Furthermore, if data obtained in space can contribute to our understanding of phenomena such as star formation (the diversity of views on which is itself evidence of our almost total ignorance), and if such data can be obtained in no other way, the scientific return is worth precisely what it costs to put the instruments in space in the cheapest manner because only by that expenditure can the data be obtained at all. Britain may be well-placed to do this cheaply and if our physicists and astronomers are to make further significant contributions to science they must have these facilities. There may be doubt now as to the measurements that will require to be made in, say, ten years' time, but we must start thinking now about the type of precision launching vehicles required.

Our proposals are exciting. Mr. G. K. C. Pardoe, of De Havilland Propellers, Ltd., has calculated that if we use only " Blue Streak " and " Black Knight," we could put 1000 lb payload into orbit at an altitude of 300 miles. It does seem, however, that rather better results might be obtainable by putting on the second stage a separating head with vernier rockets ; the payload might then be doubled at this altitude. A satellite weighing 1 ton is a very useful research platform. It has the advantage, too, that if the payload were reduced to between 50 lb and 100 lb, the head could reach escape velocity and the lunar, planetary and solar probes could be launched with the same vehicle. My assumptions may not be very accurate but I do not think they are grossly in error. It seems likely that having launched satellites, the further objectives would be within our grasp. For this reason, the adverse judgment of the Advisory Council appears premature.

The Advisory Council has made its decision on the basis of cost, and so must we. One way of arriving at an estimate is to consider evidence from the United States. The National Aeronautics and Space Administration is authorised to spend 500 million dollars a year on this type of work. It has twelve major projects—most of them more ambitious than the satellite launcher we are considering —and the average cost is 42,000,000 dollars a year (about £15,000,000). It is well known that development costs in this country are lower for comparable products than they are in the United States. Let us assume that the ratio of cost is the same as the ratio of salaries which is, I believe, about £1 against 7 dollars. This gives a comparable average cost of £6,000,000 per annum. Many of the vehicles required by N.A.S.A. are new, whereas we are proposing to use mainly vehicles which will be developed independently in any case ; and N.A.S.A. is attempting to make good an alleged three-year differential between American and Russian space technologies, and is sponsoring crash programmes, whereas we are proposing to progress steadily, considering carefully each move before acting. Using the somewhat limited data available—not the least being that the total cost of the " Black Knight " programme up to the end of 1958 was quoted as £5,000,000—my own estimate of the cost of a space research programme of the type described would be £1,000,000 for the first year, increasing at the rate of £1,000,000 a year for the first five years, and then levelling out at £5,000,000 or £6,000,000 a year thereafter. The first satellite might be launched in 1965 or 1966, followed by one satellite every quarter, and the first lunar, planetary and solar probes over the following five years. These figures seem to be comparable with the other estimate based on N.A.S.A. expenditure.

Can Britain afford £6,000,000 a year for this purpose, compared with a total expenditure this year on civil research of £34,556,000 ? £6,000,000 a year is approximately ½d. per head of population per week. As a nation, we are probably spending something approaching that amount advertising soap powders. Britain can afford it, can do it, and cannot afford not to do it. There is no guarantee at present that N.A.S.A. will always launch our instruments—the present arrangements are only for three or four years —and if we do not launch our own at some time in the future our standing as a major power will be seriously jeopardised. Certainly we should invite other nations to share the cost—and the results and prestige—if they like, but Britain cannot afford to make that as an excuse for not getting started.

Opinion in the United States is sharply divided on the issue, whether or not to send man into space. Space is so inhospitable to man, and for most measurements man is so inferior to scientific instruments, that it seems stupid to consider sending him out with all that that entails in the way of survival kit. Nevertheless, there are some things for which men are indispensable, and I have no doubt whatsoever that there will be a manned station on the moon within thirty years.

The Advisory Council has said that we cannot afford to get there alone ; this may well be arguable in terms of the cost of the expedition and what we might learn from it, though it is not proven. But more than this is at stake. For the last 300 years this nation has exerted an influence out of all proportion to the size of its population, and it must do so again in this new technology. Co-operation with other nations may not save us much expense, and it may gain for us goodwill ; independent action may gain for us prestige ; but inactivity may gain for us nothing but oblivion.

Action will only come about if the full weight of public opinion is brought to bear on the Government. The engineers who know about these matters are hampered in what they can say by security and other restrictions, and their direct advice to the Government is suspected of bias and ignored.

Shaft Turbine Helicopters

NEW helicopters to be developed from existing machines have been announced by Westland Aircraft, Ltd. The smallest is a civil development of the " Wasp," originally designed by Saunders-Roe as the P.531 for military use : the Blackburn A.129 engine will be fitted.

The remaining machines are variants of Sikorsky designs built under licence. A " Whirlwind " (S-55) was last year fitted with a General Electric T-58 engine (see page 78, August 14, 1959) and machines are now to be produced for both civil and military purposes with the British-built version of the T-58, the D.H. " Gnome."

The Sikorsky S-56 is already being built in a heavily modified form with two Napier " Eland " engines as the " Westminster," two prototypes of " flying test rig " status being in existence. There is now to be built a mock-up of a true flying crane; since the S-60 is already flying this will be presumably equivalent to an S-64.

The S-61 amphibian will be built in a version using two Napier " Gazelle " engines and be intermediate in power between the versions with two and with three T-58 engines.

A turbine-engined land " plane " was a stage omitted in the development of the S-58 proper, the U.S. Navy going straight from the four-bladed HSS-1 with the 1525 h.p. R.1820 to the amphibious five-bladed HSS-2 with two 1175 h.p. T-58 units which was the original of the S-61 : Westland, however, is to build this missing link in the form of a " Wessex " mark II with two " Gnome " (i.e. T-58) engines : flight trials will take place this year.

Automatic Sheet Metal Grading Machine

AN automatic sheet metal grader has been designed and built by the Bren Manufacturing Company, Team Valley, Gateshead, for a company in the United States, which specialises in the manufacture of shearing lines and other equipment for handling metal in coil. Prior to the introduction of this "Crabtree" grader the machines supplied by the American firm were designed for automatic selection in grading sheets but the supply of pallets, their positioning, disengaging and unloading were effected manually. With the new machine all operations, with the exception of the manual removal of loaded pallets, are carried out automatically. It is stated that this first automatic grader will probably be installed in a sheet preparation line in the canning industry, although its designers envisage a wider field of application in electrolytic tinning lines and factories engaged in aluminium sheet production.

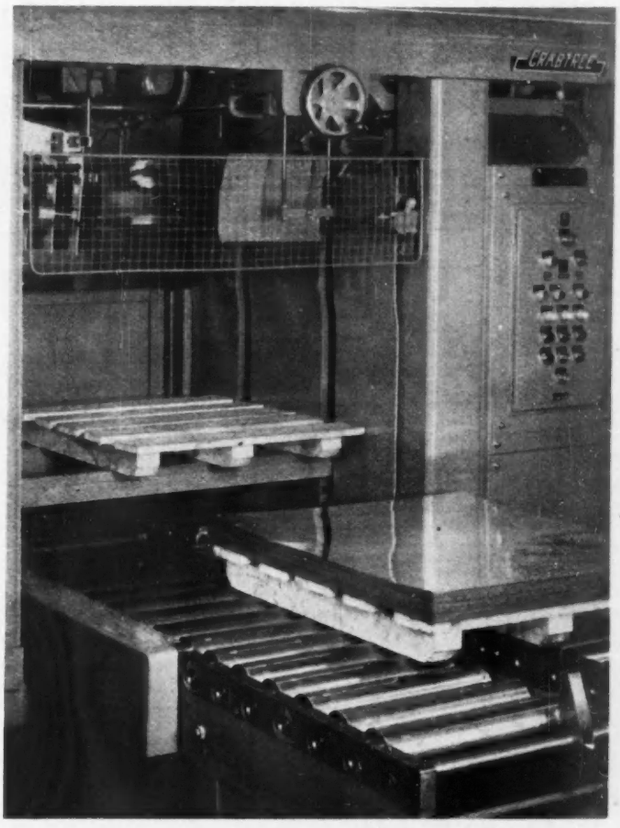
The new grader, to be seen in our illustrations, is of two-station construction and, acting on signals from a production line inspection station, it automatically separates prime and reject sheets and stacks them on pallets. It is capable of handling sheets from 18in by 24in to 44in by 48in at a maximum rate of 175 sheets a minute, and will handle pallet loads of up to 9000 lb. Its conveyor belt system, which normally runs at about 700ft per minute, has a steplessly variable speed from 100ft to 1200ft per minute.

The inspection section of the shear line to be coupled through an electronic memory device to the grader control is arranged to detect sheets outside the thickness tolerance of ±0·0005in, and check for perforations and surface flaws. Rejected sheets are removed at the first station of the grader and prime sheets pass on for stacking at the second station. The grading machine itself has a rigid frame, in the central cabinet of which are enclosed the main control gear and the 3 h.p. motor driving its conveyor and pallet handling roller system. The sheet stacking mechanism and method of operation is similar in both the reject and the prime sheet stacking sections of the machine.

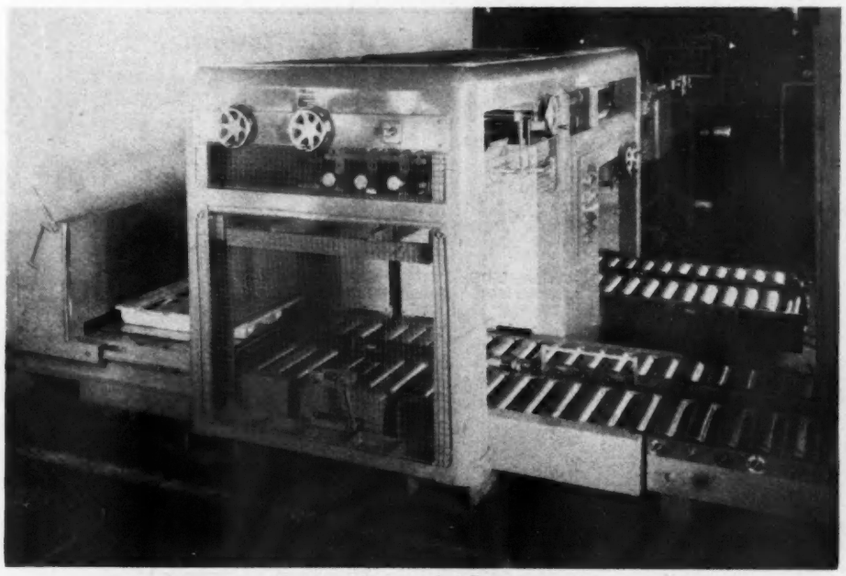
In the cycle of operations sheets pass from the shear line on to the grader conveyor and a gate on this conveyor is operated by the inspection memory device as it picks up a reject sheet and the sheet is diverted to a lower conveyor leading to the reject stacking enclosure. Prime sheets pass straight on to the stacking station at the end of the machine shown in the foreground of our illustration. Just beyond the reject gate there is a mechanism which can be operated to throw out single sheets, when required, for individual inspection purposes.

At the stacking station the sheets drop down between guides to pile up on a pallet supported on a carrier beam assembly which is raised and lowered on four screws driven through gearing by a 5 h.p. reversible motor. When a preset number of sheets has been counted on a pallet by a photo-electric cell a trip is energised to start the automatic unloading and pallet changing cycle.

First four bars are rapidly extended across the width of the stacking enclosure to catch and support the flow of sheets which continues to be deposited by the conveyor whilst pallet changing is effected. When these bars are in position the carrier beam motor is switched on to lower the filled pallet on to a line of floor rollers which extends through the lower part of the enclosure. The roller drive starts and as the filled pallet is carried out of one side of the machine an empty pallet is carried into the enclosure from the opposite side. This empty pallet is halted in the correct position over the carrier beams by retractable stops and the beam drive is re-started to raise the pallet to its stacking position. As the pallet is elevated, the retractable bars on which the pile of sheets has been building up register in slots between its platform slats. When the load has been transferred from the bars on to the pallet the bars automatically retract. The stacking operation then proceeds on the pallet until the machine is ready for the next cycle of pallet changing.



Prime sheet stacking station, part of the way through the automatic unloading cycle. Sheets can be seen being stacked temporarily on three bars until the new pallet is in position



Grading machine for automatically separating prime and reject metal sheets and stacking them on pallets

As a full pallet reaches the end of the ejection conveyor an alarm bell rings and a coloured warning light is illuminated, both warnings remaining effective till the pallet has been removed. A warning bell is also sounded if the supply of empty pallets has been exhausted. The complete line can be stopped automatically in the event of an excess accumulation of sheets along the conveyors, and a limit switch stops the machine should the pallet carrier beams be elevated beyond a preset height. Through handwheels at the sides and rear of the machine its guides are easily adjustable for the range of widths and lengths of sheets it is designed to handle.

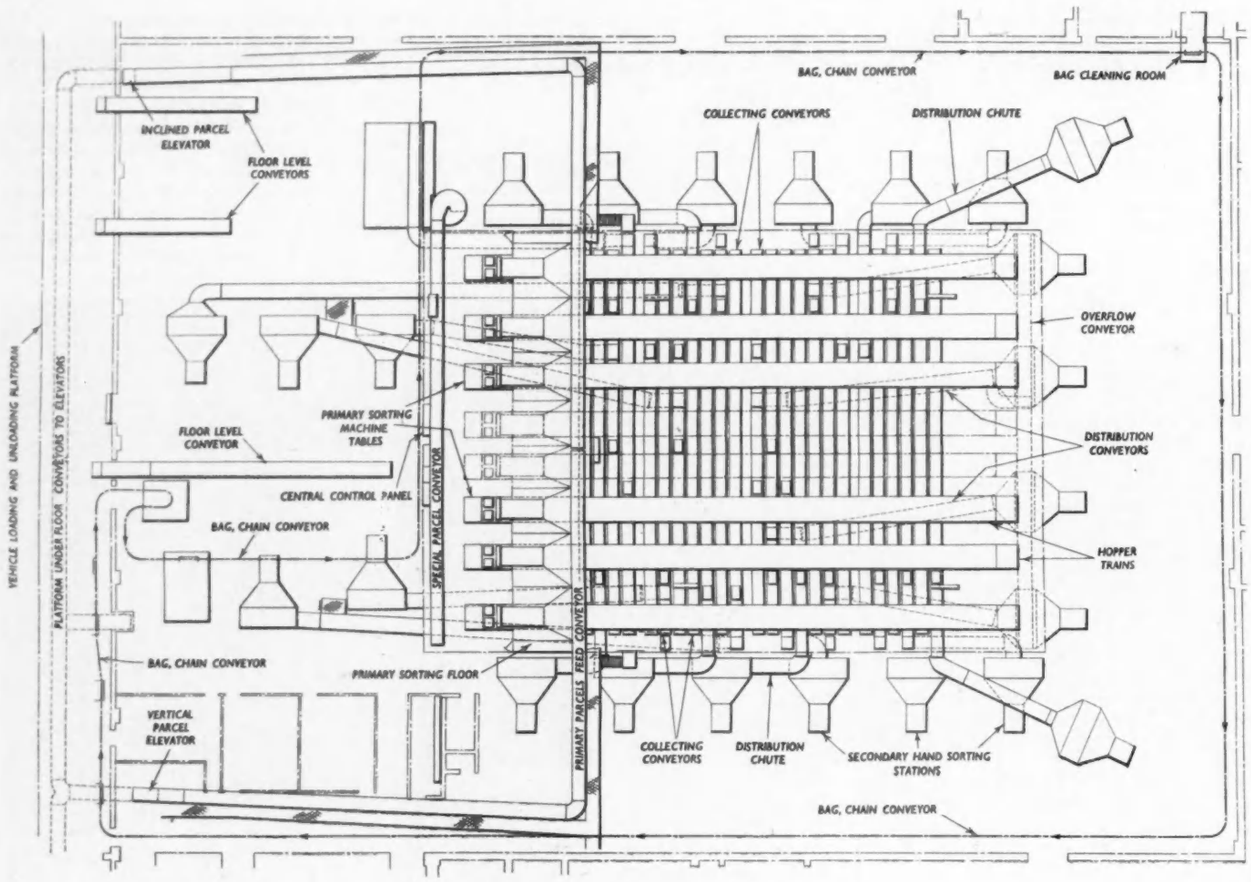


Fig. 1—Parcels sorting plant layout

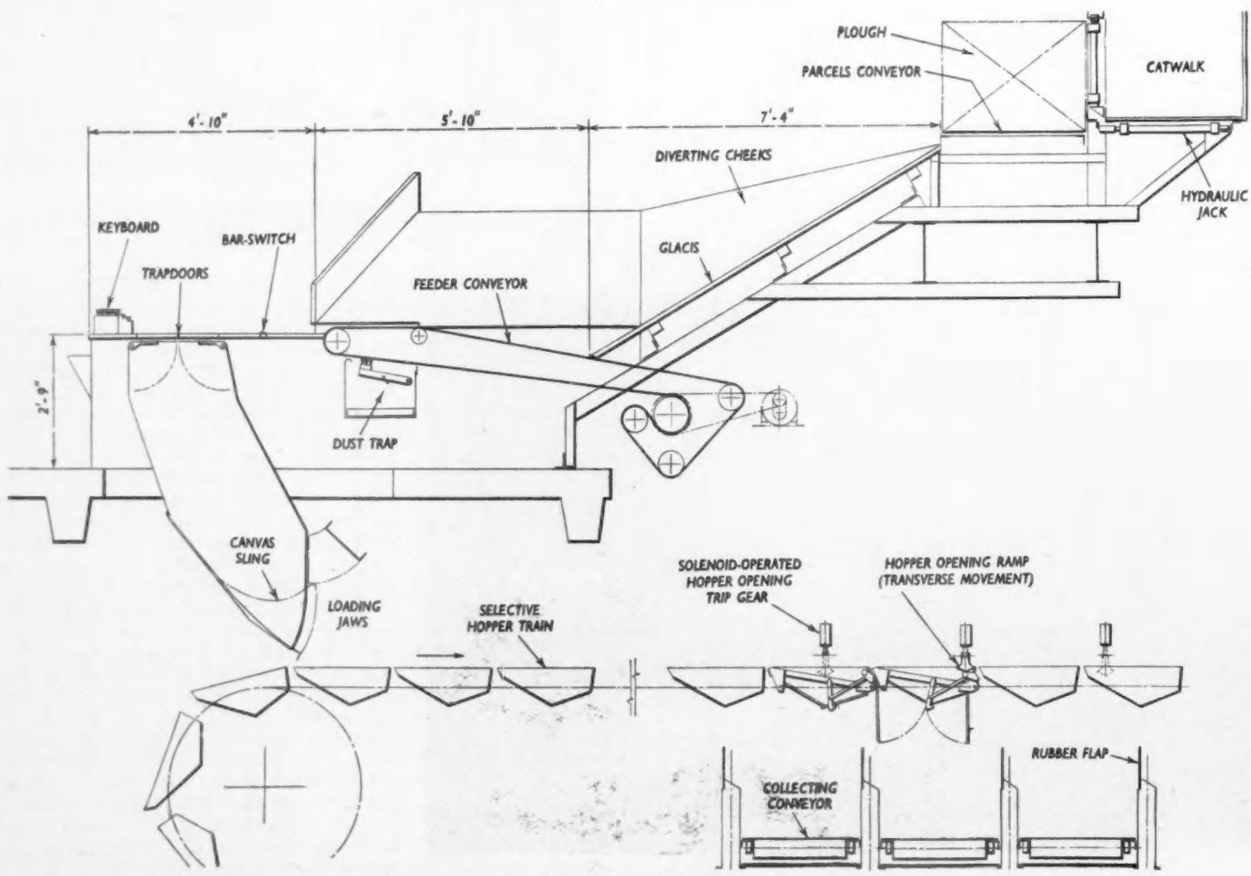


Fig. 2—Primary parcels sorting equipment and conveyor arrangement

Mechanised Parcels Sorting Office

A mechanised sorting office, equipped to handle up to 250,000 parcels a week, which has been opened at Leeds by the Post Office, is stated to be the most highly mechanised establishment of its kind in Europe. The equipment installed was designed and built by Sovex, Ltd., and was developed in collaboration with the engineering department of the Post Office after long trials with prototype plant.

THERE can be few things more difficult to handle and sort by mechanical means than the variety of parcels with which the Post Office has to deal. The complications involved in developing any mechanical system can be appreciated when it is remembered that, in this country, the Post Office is called upon to accept and deliver all sizes and shapes of parcels broadly specified to be within the limiting dimensions of 3ft 6in long and a combined length and girth of 6ft, and weighing up to 15 lb for home delivery or 22 lb for foreign delivery. For some thirty years this problem of handling and particularly sorting has been studied by the engineers of the Post Office, as the work entailed involves the use of a considerable amount of manual effort, man-power and space. The cost of this work is such that the attainment of even small individual savings by mechanical handling result in the achievement of considerable overall economies.

An outcome of extensive studies and trials with prototype equipment designed and built in collaboration with Sovex, Ltd., St. John's Road, Erith, Kent, the firm o mechanical handling specialists, is a mechanised parcels sorting office which has recently been opened at Leeds. This office is equipped to handle up to 250,000 parcels a week and is stated to be the most fully mechanised establishment of its kind in Europe.

The new plant has been installed in a building having a floor area of some 270ft by 320ft, and in which a high standard of lighting, heating, ventilation and amenities make for excellent working conditions. For the installation of the plant in this single-storey building there have been erected two island floors, one for the parcel sorting machinery and the other to carry a primary sorting section. The general layout of the building and the sorting plant can be seen in the plan we reproduce.

An enclosed loading and unloading dock at one end of the building is designed to accommodate some twenty-five postal vans backed up to the platform. Bags of incoming unsorted mail are unloaded from and bags of outgoing sorted parcels loaded into vans at this platform. Under the system followed, the contents of the incoming bags of unsorted parcels are emptied down chutes in the floor of the platform as shown in Fig. 3, and the empty bags clipped on to a chain conveyor running along the rear wall. This chain conveyor system and its uses will be dealt with at a later stage in this article.

The parcels unloaded into the platform chutes fall into one of two underground belt conveyors running almost the full width of the building. These conveyors can be run in either direction to deliver the parcels into the boots of elevators at each end. Normally, one elevator would be sufficient to handle all parcels but two have been installed to ensure that a breakdown of one would not stop the parcel feed into the plant. Two different designs of belt elevator have been installed, one of which carries the parcels up an incline of 55 deg., whilst the other is of vertical rising design. The inclined belt elevator is of the twin-band type in which the parcels are held in contact with the main carrier belt by the slack side of a parallel free running belt driven independently and weighted by crossbars—the slack side of the free running belt being loose enough for it to conform to the size and shape of all kinds of parcels.

The vertical rising belt elevator is of a new design developed by Sovex, Ltd., and comprises a driven vertical rising belt to the carrying face of which there is held in contact a free running loading belt similar to that of the inclined belt. The parcels are held between these two belts by a pressure which is maintained over the whole rear surface of the loading belt through an inflated air bag. This air bag extends over the full height of the loading belt and on the bag face are mounted a series of wooden rubbing slats which reduce belt friction and prevent wear on the bag fabric. A pressure of some 10 lb per square foot is maintained in the air bag and the degree of flexibility it imparts to the loading belt ensures that parcels of all sizes and shapes are fully supported as they are raised by the vertical elevator belt.

Fig. 4—Primary sorting floor. Parcels brought in on the elevated conveyor on the left are delivered on to the sorting counter enclosures. The conveyor on the right takes awkward parcels to a special sorting section

Fig. 3—Vehicle dock with bags of parcels being emptied down hatches on to a belt conveyor in the foreground. Bags of sorted parcels are being loaded at the far end

The main elevator belt is driven by a 7½ h.p. motor and this motor is arranged to start after a motor-driven blower has inflated the air bag to the required pressure.

These elevators deliver on to a conveyor system, situated just below roof level, which carries the parcels to a feeder belt running across the width at the rear of the primary parcel sorting floor shown in Fig. 4.

Twelve sorting equipments arranged in pairs have been installed in this primary section and space has been left for the introduction of four further equipments at a later date. A diagram we reproduce on page 126 gives a cross-section of one of the sorting tables and its associated equipment. At the rear of the parcel delivery conveyor there is situated, at each sorting station, a hinged diverter panel which can be swung out across the conveyor by a hydraulic ram. These diverter panels are swung out, as required, to plough a supply of parcels off the conveyor into a storage enclosure behind a sorting station. The parcels slide down a glacis forming the sides and back of the storage enclosure and rest on a short belt conveyor which forms the base of the enclosure. A spring-loaded switch bar runs across the width of the table between the sorting stations and the parcels enclosure and whilst this bar is held down by parcels the enclosure conveyor motor is switched off. When only a preset weight of parcels is left on the table the switch bar rises and the conveyor drive is automatically started to feed a further supply of parcels forward on to the table. Thus a constant feed of parcels is automatically maintained to the sorting stations.

At each parcel sorting station the operator has a small keyboard carrying twenty-four push-buttons, of which twenty-two are, according to a code, used to select the destination of parcels in the primary sorting operation. The other two buttons on the keyboard are spares and are not being used at present. The operator pulls parcels in turn on to a pair of trap doors set in the table in front of him and depresses the push-button appropriate to its address. The trap doors then swing down to drop the parcel into a canvas sling arrangement, known as a "loading jaw," below and then swing up again into their loading position. Up to thirty parcels a minute can be handled by each operator at a sorting station, although the normal speed is of the order of fifteen to twenty parcels. At times unduly long or awkwardly-shaped parcels not suited to the sorting equipment are delivered to this floor and they are transferred to a separate belt conveyor on one side for return to a special sorting station.

The canvas sling down which a parcel gravitates from a sorting trap provides an inclined chute and the parcel comes to rest in a loop at its lower end. At each cycle of operations the outer end of the loop is lowered and the parcel gravitates gently down into a compartment of what is termed a "selective hopper train" system below. In this system twelve "hopper-trains," a pair of which is shown in Fig. 5, serve the twelve sorting stations and these lines of trains extend down the building above a series of twenty-four primary "collecting" belt conveyors set at right angles across the width. Two of these belts, corresponding to the unused buttons on the keyboard, are spare at present. The loading gear is timed to deposit each parcel it receives when a hopper is registered below it, and until this gear has cleared itself, the sorting table trap will not reopen.

The driving shaft for the chain of each hopper train also drives a memory equipment in which pin wheels are set in accordance with the buttons depresesd at the sorting table. Cams on a driven countershaft operate the hopper loading gear through a system of push-rods and links incorporating a solenoid which prevents the sling release operating unless it contains a parcel and a hopper is correctly positioned. The main shaft also drives a layshaft and single revolution clutch which controls the opening and closing of the trap door of the sorter's table in accordance with the overall speed of the conveyor system.

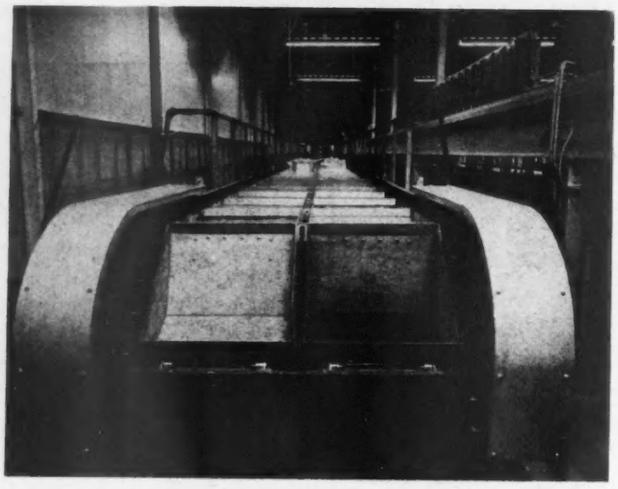


Fig. 5—Return end of a pair of "hopper trains." The solenoid-operated hopper release units for each distribution conveyor can be seen on the handrail stanchions

In the memory equipment, to be seen in Fig. 7, a separate pin wheel is provided for each of the possible twenty-four collecting conveyors corresponding to the buttons on the sorter's keyboard. Depression of a keyboard button actuates a magnet to push a pin sideways from a wheel appropriate to the selected collecting belt conveyor into which a parcel travelling along the hopper train has to be deposited. Thus, through the main drive of the hopper train, there is a timed relationship between the speed of the memory equipment and the distance a hopper travels after a parcel has been deposited in it. At the end of a time determined by its setting in the wheels of the memory equipment, the pin moved by the sorter's button engages a contact which actuates a solenoid switch. Along the full length of each hopper train a separate solenoid unit, operated from the memory equipment, is mounted on side supports above each of the twenty-four collecting belt conveyors.

When one of these solenoid units at a collecting conveyor is energised, it swings a trip out as the leading edge of the pre-selected loaded hopper reaches the conveyor. An inclined ramp on the leading end of this trip contacts and releases a locking mechanism holding closed the flap doors forming the floor of the hopper, so that the parcel it contains can fall freely on to the collecting conveyor. Thus, with this system of timing and control of solenoid release switches, parcels in various compartments along the twelve trains of sorting hoppers installed can be released at any of twenty-four points without fear of being deposited on the wrong collecting conveyor. The flap doors of the hoppers are automatically closed and locked as they pass over the sprocket drums at the return ends of the hopper trains. In the event of a solenoid switch or a trip mechanism not working to open the flap doors, a parcel remaining in a hopper is deposited over a chute at the end of the line on to an "over-carry" belt conveyor at the return end of the hopper trains.

Each collecting conveyor delivers its parcels into either chutes or distribution conveyors situated below the collector conveyors and leading to the storage concentrators of secondary sorting stations, shown in Fig. 6. At these stations which, as can be seen on the plan, are arranged round the main conveyor system, hand operatives sort the

Fig. 6—Secondary sorting stations, showing storage concentrators and chain conveyor for outgoing bags of sorted parcels along the wall on the right

parcels into bags ready for despatch. In order to prevent the concentrators at any one station becoming overloaded with parcels, a photo-electric cell is fitted at the foot of each feed chute. When this light beam has been broken for a preset period by a stationary pile of parcels, the motor driving the appropriate collecting conveyor is automatically switched off. At the same time a signal light is switched on in the primary sorting room, to show that no further parcels should be despatched to that section. Simultaneously with the illumination of the signal, the parcel release solenoids associated with that selection are disconnected. Any

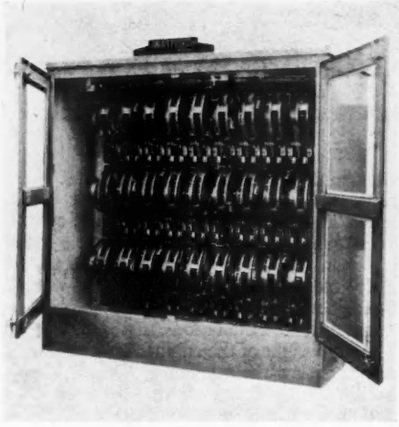


Fig. 7—Pin wheel " memory " equipment controlling the " hopper train " parcel release units

parcel thereafter sorted in to this selection will not be discharged from the hopper train but pass on to be discharged on to the over-carry conveyor.

Mention was made of a chain conveyor system at the vehicle loading and unloading platform: this system extends round the two sides and rear wall of the building. It is designed to carry a maximum weight of 80 lb at 4ft spacings along its length and it is continuously driven by a 5 h.p. motor through a fluid coupling at 60ft per minute. The conveyor is used for carrying bags only and for this purpose is fitted with Post Office design self-gripping and automatically self-releasing load carriers coloured red, yellow, blue and green, each colour denoting the release position of the bags in the building or at the loading dock.

The empty bags placed on the carriers at the unloading dock are carried to a clearing station in one corner of the building, where they are automatically released down a chute.

This initial section of the track is also used to carry incoming bags of registered mail to a special handling section in the building. As can be seen in Fig. 6, the chain system passes along the wall just above floor level behind the final hand-sorting stations. As each mail bag is filled at these stations, it is taken across the short width of floor and hung on a carrier of appropriate colour coding. When the carriers reach the van dock they automatically release the bags at any one of three vehicle loading points selected, according to the colour code.

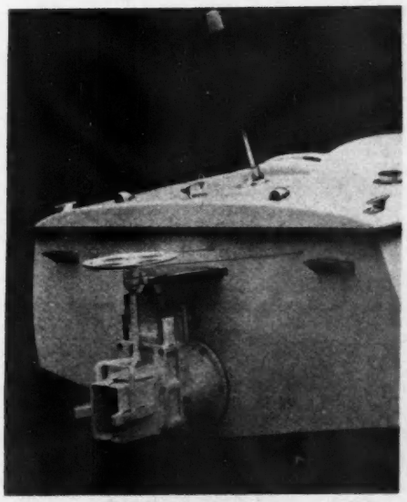
Practically all of the electrical and control equipment for this installation was supplied to the requirements of Sovex, Ltd., by the Watford Electric and Manufacturing Company, Ltd.

Some Engines at the Boat Show

EARLS COURT, London, was the venue of the sixth National Boat Show which was open from December 30, 1959, to January 9, 1960, and where there were on view a whole range of small craft for both pleasure and work purposes. The exhibits included prams, canoes, dinghies, sailing craft ranging up to the 50ft ketch " Melora III," speed boats and runabouts ; a wide variety of motor craft, of which the largest was the 52ft " Monaco " cruiser ; catamarans, the Dowty-Hamilton water-jet boat and the " Hovercraft " S.R.N.1, built by Saunders-Roe, Ltd. In addition to the boat exhibits, engine manufacturers displayed various designs of engines having a range of power suitable for small craft and particularly noticeable were the numbers of outboard motors on view.

The power for the Dowty Turbocraft is provided by a marinised Ford " Zephyr " engine rated to develop 70 b.h.p. at 3160 to 3700 r.p.m. and propulsion is by a two-stage jet unit in which water is drawn into a pump through a steel grid fixed flush with the bottom of the boat and ejected through the transom. Reaction from the jet stream provides the propulsive force. A gate, controlled by a hand-operated lever system, ensures that the jet stream is cleared for ahead movement, blanked or deflected forward under the hull to give astern movement. The latter eliminates the need for reversing gear, while the jet unit provides cooling water to the engine and can also be used as a bilge pump. Our illustrations show the steering gear and the jet unit.

Three examples of the " Medina " 7½ h.p. water cooled two-stroke outboard motor were on the stand of Saunders-Roe, Ltd. This is a two-cylinder unit of 2⅛in bore by 1¾in stroke and a capacity of 200 c.c. and



Steering gear of Dowty Turbo-craft

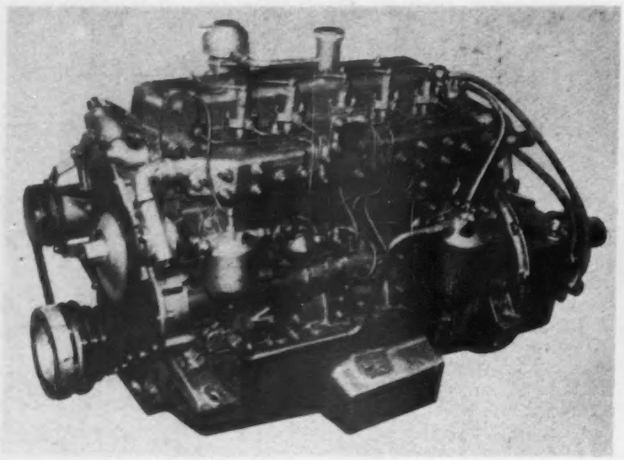
runs at 4250 r.p.m. The drive is through gears, having a ratio of 14 to 26, to the propeller, of which there are three models available, all having a diameter of 8in. There is a two-bladed propeller of 9in pitch and two three-bladed propellers having a pitch of 8in and 7in, respectively. Fuel is carried in a remote tank, of 3¼ gallons capacity, fitted with a hand-priming pump, and is delivered to the carburettor by a diaphragm lift pump. All castings of the unit, which weighs 59 lb, are of anodised corrosion-resistant light alloy and the crankshaft is a nitrided steel forging, while the connecting rods are light alloy steel forgings fitted with steel backed white metal shell bearings.

Part of the stand was devoted to the research facilities, with emphasis on yacht

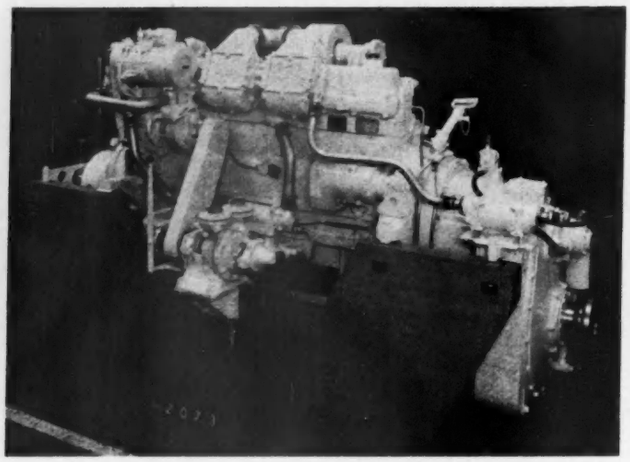
Propulsion unit of Dowty Turbo-craft

research and development, since the company is now engaged on a programme for the Red Duster Syndicate, which is planning to build a 12m yacht as a contender for the America's Cup. Of particular interest was the Yacht Slide Rule, the function of which is to correlate information concerning sail and hull forces and compute the factors giving the best performance under sailing conditions. The slide rule has three parts, namely : the fixed sail plate ; the horizontal sliding parallelogram of velocities plate, and the vertical sliding hull plate. The sail plate embodies the results of wind tunnel tests on sails and has marked on it the " Gimcrack " sail coefficients as used in America, while on the hull plate are the generalised tank tests on a particular hull form. With the horizontal and vertical sliding plates set to an angle of heel, it is possible to read off the best speed made to windward and the true wind speed as a ratio of the chosen course speed.

Besides showing examples of its 6 h.p., 16 h.p. and 35 h.p. outboard motors and a number of well-established marine engines such as the Four/99, P3/144, Four/270 and the S.6, Perkins, Ltd., displayed a new 5-litre diesel engine. This is the Six 305 (M) six-cylinder, vertical in-line unit developing 84 s.h.p. at 2400 r.p.m. intermittently and 68 s.h.p. continuously at 2000 r.p.m. The engine, which we illustrate, is fitted with a MR11/2B oil-operated gearbox, and has a bore and stroke of 3·6in by 5in, a cubic capacity of 305·3 cubic inches and a compression ratio of 17·4 to 1. The cylinder block is of high-duty cast iron alloy monobloc construction cast integrally with the crankcase and fitted with dry pattern pressed-in renewable high-duty thin-wall steel chrome plated liners. Two overhead valves per cylinder are carried in the cylinder head casting of alloy iron, and are operated from a camshaft, of special cast iron alloy, mounted high on the air intake side of the cylinder block and supported by four bearings. The flat-topped high silicon alloy pistons have three compression and one oil control rings



Perkins Six 305(M) marine diesel engine of 68 s.h.p. at 2000 r.p.m.



Rolls Royce turbo-charged engine of 300 b.h.p. adapted for 73ft trawlers

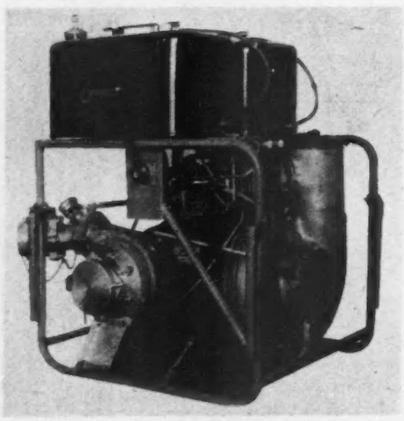
above the gudgeon pin and one scraper ring below. Replaceable copper lead-lined thin-wall big end bearings and small end lead bronze-lined bushes are fitted to the connecting rods, which are light "H" section molybdenum alloy steel stampings, while the crankshaft, also a molybdenum steel stamping, is carried in seven thin-wall prefinished steel backed copper lead-lined bearings. There is a distributor pattern fuel injection pump and a diaphragm lift pump, and the engine is pressure lubricated by a gear pump, while the fresh water cooling system includes a centrifugal circulating pump. The engine and gearbox weigh 1050 lb.

We also illustrate the Perkins "Mars" gas turbine pump which weighs 172 lb and delivers 500 gallons of water per minute at 100 lb per square inch discharge pressure and 10ft suction lift. The turbine, which is 22in high by 17in wide and 24in long, including gearbox, runs equally well on diesel fuel, paraffin or low-grade petrol, develops 50 h.p. at 40,000 r.p.m. and has a weight of 98 lb. The single-stage centrifugal pump has its impeller mounted directly on the gearbox output shaft, which has a speed of 4400 r.p.m.

The Larsson-Wilson Marine Motor Company, Ltd., exhibited several Albin petrol-paraffin engines ranging from 5 h.p. to 40 h.p. and a G.62 diesel engine rated at 120 b.h.p. at 1600 r.p.m. This is a direct injection six-cylinder unit of 120mm bore by 145mm stroke with a compression ratio of 17 to 1. The cylinder block, cast integral with the crankcase, has wet pattern cylinder liners and the aluminium alloy pistons have three compression rings, the upper one chromium-plated, and two scraper rings. Valves of heat-resisting steel with Stellite seats and hard chromium-plated stems are fitted. The connecting rods are of drop forged alloy steel, heat-treated and drilled for pressure lubrication, and the cast crankshaft is of a special high-strength alloy and supported in seven copper lead-lined steel shell bearings. The injection pump is gear driven from the crankshaft and the feed pump is driven from the camshaft of the injection pump. Cooling is by fresh water which is circulated by a centrifugal pump and cooled in a heat exchanger through which sea water is passed by a self-priming bronze rotary pump. Also on view was an Albin-Husqvarna single-cylinder, air-cooled outboard two-stroke with loop scavenging having a bore and stroke of 46mm by 46mm, and an output of 3·5 h.p. at 4200 r.p.m. This engine, of 77 c.c. capacity, has a compression ratio of 1 to 5·6 and drives a three-bladed propeller of 190mm diameter by 143mm pitch at 2300 r.p.m. through helical bevel gears having a ratio of 15 to 27.

Four-, six- and eight-cylinder models from its range of engines were shown by Rolls-Royce, Ltd., and particularly prominent was a turbo-charged eight-cylinder engine which has been adapted for fitting to seiners and a 73ft dual-purpose fishing boat. This liquid-cooled, four-stroke, direct-injection, compression ignition engine, seen in our illustration, is of monobloc construction with removable wet liners and has a bore of 5½in, a stroke of 6in, a compression ratio of 14 to 1, and a power rating of 300 b.h.p. with a propeller speed of 300 r.p.m. The fuel system includes twin piston mechanical lift pumps and a jerk pattern injection pump with an all speed hydraulic governor delivering fuel through multi-hole injectors. The sump ensures that lubrication is adequate under all safe conditions of pitch and roll, and the oil is handled by pressure and scavenge pumps. A belt-driven centrifugal pump circulates the engine coolant and a centrifugal pump circulates sea water through the engine coolant heat exchanger and the gearbox oil cooler. At the forward end of the crankshaft is a Twin Disc power take-off box with over-centre clutch and able to take off up to 65 h.p., while there is a twin-belt power take-off drive to the bilge and wash-down pump.

On the stand of R.J.C. Motors and

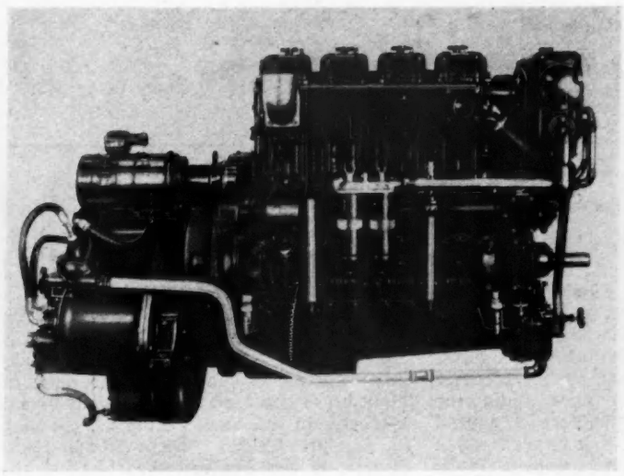


Perkins (Solar) "Mars" gas turbine with 500 gallons per minute pump

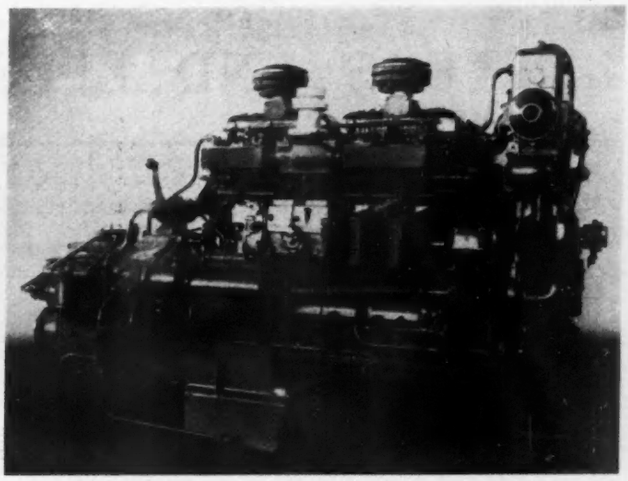
Marine Engineers, Ltd., were G.M. diesel engines including a four-cylinder "53" series engine and a "Vee" eight-cylinder "71" series engine. The two-cycle "53" series unit has a compression ratio of 17 to 1, bore and stroke of 3½in by 4½in, a rated brake horsepower of 130 at 2800 r.p.m. and a maximum installation angle of 17 deg. The dry weight of the engine is about 1200 lb. Representing the range of "Vee" engines the 8V-71 has a dry weight, when equipped with reverse and reduction gear, of 3200 lb and is rated to develop 323 b.h.p. at 2300 r.p.m. The bore is 4¼in and the stroke 5in and the total swept volume is 567·4 cubic inches. Both engines have unit injectors, one per cylinder, which meter, pressurise, atomise, and inject fuel in a single operation.

Examples of the wide range of engines produced by the Bergius Company, Ltd., were on show and included two additions to the model T "Kelvin" engines, namely, the T4 of 120 h.p., illustrated herewith, and the T6 of 180 h.p. This design of engine develops 30 h.p. per cylinder at 1000 r.p.m., and has a bore and stroke of 6½in by 7½in and a brake mean effective pressure of 99 lb per square inch, while the compression ratio is 14 to 1. Of great structural rigidity, these engines have a heavily ribbed crankcase of high quality cast iron, to which is fitted an internally webbed sump. Single-cylinder heads are used with cylinders cast in blocks of two, and wet liners are fitted. The aluminium alloy pistons have a toroidal shaped bowl in the crown and three compression and two oil scraper rings, while the connecting rods are of forged steel and the case-hardened steel camshaft is built up in sections. Thin-walled copper lead bearings carry the underslung alloy steel crankshaft. The fuel system includes a block pattern fuel pump with feed pump, and injection is direct through four-hole nozzles into the combustion chamber. Lubricating oil is delivered at 50 lb per square inch and the engine has closed circuit cooling with a combined heat exchanger for water and oil. A centrifugal pump circulates the fresh water and a plunger pump circulates the sea water through the heat exchanger. The T4 unit weighs 2¼ tons.

Bolinder and Penta diesel and petrol engines and also a range of Penta Outboards were exhibited by Bolinders Company, Ltd. Of special interest was the Volvo-Penta "Aquamatic" inboard and outboard drive which consists of a Volvo-Penta BB.70 unit, and an outboard drive mounted in rubber through the transom so that no engine



Model T4 Kelvin diesel engine of 120 h.p.



Mark RKRN 6 Thornycroft diesel engine of 125 h.p. at 1600 r.p.m.

bearers are required. The propeller thrust balances the weight of the engine. This is a four-cylinder, overhead valve four-stroke unit of 3·12in bore by 3·15in stroke and a compression ratio of 8·2 to 1. Special alloy cast iron is used for the cylinder head and cylinder block which is cast integral with the crankcase. The chill cast light alloy pistons have two compression and one oil control rings and the drop forged, case-hardened connecting rods have lead bronze-lined big end bearings. Three similar bearings carry the drop forged crankshaft. The engine is pressure lubricated and sea water cooled and has a maximum output of 65 h.p. The output of the engine is transmitted to the outboard drive through a Rzeppa universal joint and two sets of right angle gears; the ahead and astern drive is through dog clutches. The outboard drive can be swung up and the complete unit, which has a weight of 465 lb, is operated by a single lever.

Nine representative engines, including three new units, namely, the 950 R.M.R., the 23 C.V.R.M.R. and the A.S.2 R.M.R., were seen on the stand of Petters, Ltd. The 950 R.M.R. is a four-cylinder Standard petrol engine with a reverse and 3 to 1 reduction gear, rated at 20 s.h.p. at 1000 propeller revolutions per minute. The bore and stroke are 63mm by 76mm and the compression ratio 7 to 1. Chromium iron is used for the cylinder block and cast iron for the cylinder head and aluminium alloy for the pistons. Both the connecting rods and crankshaft are of forged steel and have steel backed bearings lined with white metal. A gear-driven high-pressure oil pump provides forced lubrication throughout the engine which is cooled by direct sea water circulation. Electric starting is fitted and the complete unit has a weight of 347 lb.

The 23 C.V.R.M.R. engine, of 3·31in bore by 4in stroke, has a compression ratio of 20 to 1, and drives the propeller at half engine speed through a reverse reduction gearbox, while at an engine speed of 3000 r.p.m. the rated continuous output is 42 s.h.p. The cylinder block, of monobloc design, is cast in high duty chrome iron alloy and fitted with centrifugally cast slip fit liners of phosphorous chromium cast iron. Cast iron is employed for the cylinder head which incorporates Ricardo " Comet " swirl chambers, and the aluminium alloy pistons have a swirl chamber in the crown. The connecting rod is a manganese molybdenum steel stamping and the crankshaft is of heat-treated nickel-chrome molybdenum steel, and both are fitted with steel backed bearings lead indium-lined. Lubrication and cooling are as for the 950 M engine and the unit weighs 830 lb. The 23 C.V. is the vehicle version of the 2260 c.c. Standard engine.

The Armstrong Siddeley air-cooled A.S.2.R.M.R. diesel unit, rated at 20·9 s.h.p. at 1800 r.p.m., has a bore and stroke of 4·25in, a compression ratio of 15 to 1, and dry weight of 899 lb. Both the cylinder and cylinder head are of cast iron and heavily finned and the light alloy pistons have a hemispherical bowl in the crown. The connecting rods are steel stampings and the crankshaft is in forged steel carried in steel backed white metal bearings. The big end bearings are similar except that the upper half is of lead bronze. Fuel is delivered by injection pumps operated by rocker gear from the gear-driven camshaft, and lubrication is by rotary pump, while cooling is by air from the flywheel fan, directed around the cylinders and cylinder heads.

John I. Thornycroft and Co., Ltd., exhibited a 28ft 6in cabin cruiser having a standard glass fibre reinforced plastic hull, fitted out to a particular specification, and several engines representative of those manufactured by the company. Among the power units was a mark RKRN6 engine, seen in our illustration, which is naturally aspirated, has a bore of 4¾in by 6½in stroke, a compression ratio of 16 to 1, and has a maximum continuous rating of 96/125 s.h.p. at 1200/1600 r.p.m. Dry pattern centrifugally cast alloy iron liners are fitted to the cylinder block, cast in chromium iron, and the tin-plated aluminium alloy pistons have a toroidal combustion chamber in the crown and three compression and two scraper rings, the top compression ring being chromium plated. The alloy steel forged connecting rods have phosphor bronze bushes at the small end and copper lead-lined big end bearings. Seven similar bearings support the nitride hardened crankshaft. C.A.V. fuel injection equipment is fitted, and lubrication of the engine is by a gear-driven high-output gear pump. The engine is fresh water cooled and fitted with a combined heat exchanger and header tank. A centrifugal pump circulates the fresh water and a belt-driven rubber impeller pump supplies the sea water. The engine with reverse reduction gear has a weight of 3400 lb and a maximum installation angle of 11½ deg.

Examples of the well-established engines manufactured by Enfield Industrial Engines, Ltd., were shown by University Marine, Ltd., and in addition there was the company's new " lightweight " unit. This is the M.350, a high-speed, air cooled, single-cylinder diesel engine having a bore and stroke of 3in, a capacity of 350 c.c., a compression ratio of 23 to 1, and a dry weight of 250 lb. The speed range is 500 to 3000 r.p.m., and the engine has a continuous output of 1·9 s.h.p. at 1000 r.p.m., rising to 4·1 s.h.p. at 3000 r.p.m. The heavily finned cylinder head is of cast iron and the crankcase is a rigid aluminium alloy casting: the piston is of aluminium silicon alloy and fitted with three compression and two scraper rings. The connecting rod is a nickel steel heat-treated forging and the crankshaft is of forged steel, induction hardened, and both main and big end bearings are of heavy-duty steel backed pattern. A hardened forged steel camshaft operates the overhead valves of " Silchrome " material and fuel injection is by C.A.V. pump and pintle-hole nozzle, while lubrication is by a gear pump. Cooling of the engine is effected by a fan, integral with the nickel cast iron flywheel, which draws air in over the oil sump and discharges the air at high velocity around the cowled cylinder and cylinder head. A centrifugal governor gives accurate control of speed between 1000 to 3000 r.p.m. and an over-riding control provides for varying the speed down to 500 r.p.m.

Four Mercedes-Benz water cooled, four-stroke diesel engines were on view and included the MB.820Db. twelve-cylinder vee supercharged engine of 1350 h.p. at 1500 r.p.m.; the six-cylinder OM.326 of 155 h.p. at 1800 r.p.m.; the six-cylinder OM.321 of 94 h.p. at 2600 r.p.m. and the four-cylinder OM.636 of 35 h.p. at 3000 r.p.m. The first engine has a bore and stroke of 175mm by 205mm, a mean effective pressure of 197·6 lb per square inch, and compression ratio of 16·1 to 1. The OM.326 vertical six-cylinder in-line engine which has a total capacity of 10·81 litres, the bore being 128mm and the stroke 140mm, has a mean effective pressure of 102 lb per square inch and the compression ratio is 19·5 to 1. As for all Mercedes-Benz units, this engine operates on the pre-chamber system. The OM.321, also a six-cylinder engine, weighs 1025 lb, compared with the 1740 lb of the O.M.386. The compression ratio of the engine is 19·5 to 1 and the mean effective pressure 90·5 lb per square inch, while the capacity is 5·1 litres. The smallest engine shown, the OM.636, has a 75mm bore by a 100mm stroke, a capacity of 1·77 litres, a mean effective pressure of 84·6 lb per square inch and 19 to 1 compression ratio and weighs 400 lb.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

BATHING BEACHES AND SEWAGE

SIR,—Referring to your welcome leading article under the above heading in your issue of January 8, 1960, there is a further danger to the human race in the primitive discharge of sewage into the sea. This also deserves attention by fishermen and engineers. The consumption of fish which have fed in polluted waters has caused serious and painful illnesses in human beings.

When Professor H. O. Hettche, of the Hamburg Institute of Hygiene, was in England last October for the International Clean Air Conference, he related to me a fascinating story of his earlier medical research at Konigsberg. After many months' work the painful cramps and other symptoms from which many of the fishermen suffered were traced to the fact that they ate the livers of large eels. This had been a healthy practice for many generations but recently the estuary had become polluted and the eels feeding in its mud picked up poisons which were concentrated in their livers. These in turn incapacitated the fishermen, who ate a proportion of their catch, and possibly also poisoned some landsmen. Beware of eating fish from polluted waters !

T. HENRY TURNER

Derby,
January 11, 1960.

Book Reviews

Friction and Wear. Edited by ROBERT DAVIES. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 36s. 6d.

WE have previously commented adversely on the practice of entitling reports of Conferences when reproduced as bound volumes in such a style as to give the impression of a comprehensive treatment of a specific topic. Thus, the dust jacket of the present work bears the title *Friction and Wear* in large type and in small print " Symposium held at the General Motors' Research Laboratories." The binding itself carries the title *Friction and Wear* without qualification. The volume is, in fact, a collection of nine separate lectures. The contributors have been so well chosen, however, and the quality of the individual papers is so high that, on this occasion, the work as a whole may be considered to be more valuable than the sum of the parts so that the discerning reader will be able to obtain a clear concept of the subject as a whole. The newcomer to the subject will, however, have to read the whole of the nine lectures and then rearrange the information he has gleaned in a different order to achieve this appreciation.

In order to build up a theory of wear which will withstand the test of practical experience, it is necessary to know a great deal about the behaviour of surfaces in contact, about the effect of metallurgical properties of those surface and about the effect of environment. The volume contains original and significant contributions on all these topics.

Clearly, in order to understand wear, we must have an accurate and detailed knowledge of the manner in which bodies come into contact. It is now generally agreed that contact between surfaces only occurs at small discrete areas or protuberances which are widely distributed over the macroscopic regions usually perceived as constituting the bearing areas. It is therefore a natural starting point to study what happens when simple substances are forced together. In the final contribution of the series, Gwathmey and Dyer describe experiments in which oriented single crystals are forced together under carefully controlled environmental conditions and then separated. The experiments described were carried out in an atmosphere of hydrogen at temperatures ranging from 200 deg. to 800 deg. Cent. The consequent damage was then studied in detail and, as illustrated, consisted of a smooth central area surrounded by corrugations which are described as " fingers." The direction of these fingers was dependent on the relative orientation of the crystal planes of the original specimens and their extent depended on the time of loading. The growth of these fingers is attributed to anisotropy of surface energy. When the test pieces were allowed to cool before separation, the central area was shown to possess cavities whose shape depended on the orientation of the crystals. This observation was explained by the concentration of vacancies. Because, ultimately, certain forms of wear may be expected to originate from the crystals of metals being forced together under a high local temperature arising from friction, these experiments must be relevant to the problem. Nevertheless, it appears that they will have to be carried a great deal further, particularly with respect to the effect of shearing forces and contaminating surface films.

In practice, metal parts will be polycrystalline and different crystal orientations will come into play at separate points of contact. It is therefore of interest to see how the chemical constitution of the mating pairs affects seizure behaviour. Goodzeit describes experiments in which a number of pure metal test pieces are forced against rotating discs whilst lubricated with kerosene. The conditions of load and speed were such that the kerosene lubricant was relatively ineffective and conditions at failure could be described as clean metal sliding on clean metal. Some important conclusions arise from this work as follows : Metals which are miscible have poor seizure resistance. Of those metals which are immiscible, performance varies from good, through fair to bad. For example, metals which give good performance with steel are gold, cadmium, indium, thalium and lead, and they are all in the " B " sub-group of the periodic table as well as being immiscible with iron. However, the alkali metals, magnesium, calcium and barium, although immiscible with iron gave poor score resistance. This is attributed to a different type of bonding, the alkali metals having a pronounced metallic bonding whilst the " B " sub-group metals have varying amounts of co-valent bonding. The important generalisation, " Similar bond types tend to promote seizure, dissimilar bond types tend to resist it " should be of great assistance to engineers and metallurgists engaged on the formulation and selection of bearing metals.

The implication of Goodzeit's work which relates to drastic conditions where metal is forced against metal may have to be modified under milder conditions where films of lubricant or oxide may exert a predominant influence on the contact situation. Coffin, in a paper entitled " Some Metallurgical Aspects of Friction and Wear " takes the subject further by a series of experiments in which metals are rubbed together in a controlled atmosphere. A wide range of metals was used and, where the combinations coincide with those tested by Goodzeit, the results are in agreement.

The nature and extent of damage by rubbing pairs may take many forms but Coffin is able to generalise his results into two categories, " sliding by shear " and " sliding by welding." In the former case, the separation of asperities which have been forced together takes place at the original interface with little consequential damage. Indeed, the surface may be improved by a mild smoothing action. In sliding by welding, the opposing surfaces are assumed to bond together so effectively at the points of contact that sliding can only take place by tearing of the base metal. This leads to roughened and heavily abraded surfaces. It will be readily appreciated how such factors as miscibility, type of bond and nature of any intermetallic compounds formed may drastically affect the wearing behaviour of any combination.

Clearly, the possibility of sliding by shear is increased by contamination of the surfaces, deliberately by lubrication or inadvertently by reaction with the environment. Coffin describes experiments in which the atmosphere surrounding the tests may consist of helium rather than air. In general, the effect of air is shown to be harmful. A particular example was where a lead rider was run on a steel disc. Here, the introduction of oxygen was responsible for transferring the process from sliding by shear to sliding by welding, the presence of oxygen apparently increasing the adhesion at the interface sufficiently to cause fracture to occur within the lead. It is possible that in an oxygen or air atmosphere, the interaction at the interface is between oxides rather than between metals.

Other tests explored the effect of ambient temperature and, in general, transition from sliding to tearing conditions occurred on a critical temperature being reached. Similar experiments in which a lubricant was used showed also transition from one form of wear to another on a critical temperature being reached. This result agrees with the general ideas regarding the inception of scuffing, the transition temperature in the case of gears corresponding with Blok's " Flash Temperatures."

The next stage in the study of the subject is the effect of deliberately applied lubricants to reinforce any naturally occurring boundary layer. The action of a lubricant may be either by chemical reaction with the surface, hydrodynamic behaviour or by physical adsorption. The pioneer work of Hardy on

this latter topic has not always been confirmed by subsequent workers but in an extremely thorough investigation by Zisman, the main premises of Hardy's work have been confirmed. It is to be noted that Zisman's work was concerned with a stainless steel ball sliding on very smooth glass. A word of caution may be in place here in so far as this system may not be representative of the majority of cases where metal slides against metal in engineering practice.

A major advance represented by Zisman's work relates to the method of depositing a mono-molecular film on to the test piece. Early workers had transferred films from water surfaces in a Langmuir trough but Zisman has developed means for absorbing these films from solutions and for completely separating the resulting film-coated solid from the solvent. The effect of the means used to produce the mono-molecular layer are discussed in the paper, two aforementioned methods being compared with films deposited from the vapour phase. A great deal of data is given relating to a large number of chemical substances and this paper alone is worthy of study by anyone interested in the fundamentals of lubrication.

Irregular sliding, sometimes leading to noise and serious vibration, is often associated with poor lubrication conditions. Circumstances where the coefficient of friction diminishes with sliding velocity will, in an elastic system, provide negative damping which may cause relaxation oscillations or "stick-slip." Rabinowicz shows how this condition may arise from variations in frictional behaviour of different areas of a surface. He states that effective lubrication of a steel surface requires about 10^{-6}cm of a solid lubricant which may be a soap formed by reaction between active constituents of the lubricant and the surface itself. This is probably a fairer representation of the action of many boundary lubricants in practice than any explanation based on the adsorption of mono-molecular layers. As has been shown by earlier workers, stick-slip phenomena can usually be overcome by the provision of adequate damping within the system and, indeed, by suitable adjustment of the stiffness and relative velocity thereof.

The volume also includes an exposition by Dr. F. P. Bowden of the recent achievements of the Research Laboratory for the Physics and Chemistry of Solids at Cambridge. Our readers will already be familiar with this work.

Drutowski describes some experiments of the friction of steel balls rolling on plates. He records considerable erratic variations in the magnitude of this property, and studies the effect of hardness and other material properties. The variation of friction with load is divisible into two ranges. In the lower range, where elastic conditions predominate, the rate of increase of friction with load is considerably less than in the higher range where plastic conditions operate. The work generally supports the hypothesis that energy lost in rolling is dissipated by hysteresis losses within the material.

It being assumed that wear takes place on numerous isolated pressure points, it is necessary to consider the aggregate effect of this action on complete components. Davies presents a tentative method for the mechanical wear process based on certain assumptions. But it is difficult to accept the initial assumption that rubbing materials receive energy in *quanta*, all of which are of the same size; hence it is difficult to accept the paper as anything other than an exercise in ingenuity in manipulating statistical concepts without much interest for the practising engineer.

Taken as a whole, the volume represents a considerable step forward in understanding certain processes of wear. It is to be regretted, however, that it contains no treatment of wear due to the presence of foreign abrasives because this represents a practical case of real importance. Nevertheless, advances on the lines described in the volume are prerequisite for understanding the more complicated wear processes which occur in practice.

Recherches éxperimentales sur les ondes de choc produites par les décharges condensées dans les gaz rares. By MICHEL CLOUPEAU. Publications Scientifiques et Techniques du Ministère de l'Air, No. 352. Magasin C.T.O.: 2, Avenue de la Porte-d'Issy, Paris (15e). Price Fr.1180.

THE high-intensity flash produced when a condenser is discharged across the two electrodes of a discharge tube filled with a rare gas gives rise to a variety of spectral lines plus a continuous background of radiation which has been observed to extend from the near ultra-violet through the visible range into the near infra-red. While the total spectral distribution has been well investigated owing to its importance in such fields as photography, it seemed of importance to discover more about the time distribution of these radiations as a step towards establishing the mechanism of origin of the continuous background radiation which is still obscure. The procedure was to obtain, by means described in the paper, a stabilised discharge which could be repeated exactly, and to analyse it with a rotating mirror and spectrograph. The existence of shock waves in the plasma was established and their nature investigated.

Cutting Fluids. Esso Petroleum Company, Ltd., 36, Queen Anne's Gate, London, S.W.1. Price 7s. 6d.

THIS book was first published some seven years ago and the new edition is designed to bring the information then given up to date. It deals with "straight" cutting oils, soluble oils and solution type fluids, and gives notes on the selection, application and use of cutting fluids. The various types of Esso cutting fluids are listed at the end of the book with their recommended applications.

Books Received

Angus Gear Book. George Angus and Co., Ltd., Prince Consort Road, Hebburn-on-Tyne. Price 15s.

Das Trocknen. By F. Kneule. Verlag H. R. Sauerländer and Co., Aarau, Switzerland. Price Sw.Fr.45.

Our Mineral Resources. By Charles M. Riley. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 56s.

Six Great Engineers. By J. G. Crowther. Hamish Hamilton, Ltd., 90, Great Russell Street, London, W.C.1. Price 12s. 6d.

Watch and Clock Encyclopædia. By Donald de Carle. N.A.G. Press, Ltd., 226, Latymer Court, London, W.6. Price 50s.

Curve Surveying. By R. B. M. Jenkins. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 35s.

Automatic Refrigeration. By S. A. Andersen. Maclaren and Sons, Ltd., 131, Great Suffolk Street, London, S.E.1. Price 85s.

Garcke's Manual of Electricity Supply, 1958-59 *Edition*. Electrical Press, Ltd., 19-20, Noel Street London, W.1. Price 80s.

Modern Physics. Fourth Edition. By H. A. Wilson. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 40s.

Liverpool Overhead Railway, 1893-1956. By Charles E. Box. Railway World, Ltd., 245, Cricklewood Broadway, London, N.W.2. Price 25s.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1

NICKEL COPPER ALLOY CASTINGS
No. 3071 : 1959. Price 4s.
NICKEL AND NICKEL ALLOYS—SHEET
No. 3072 : 1959. Price 5s.
NICKEL AND NICKEL ALLOYS—STRIP
No. 3073 : 1959. Price 5s.
NICKEL AND NICKEL ALLOYS—TUBE
No. 3074 : 1959. Price 5s.
NICKEL AND NICKEL ALLOYS—WIRE
No. 3075 : 1959. Price 4s.
NICKEL AND NICKEL ALLOYS—RODS AND SECTIONS
No. 3076 : 1959. Price 5s.

This series of six standards for nickel and nickel alloys supersedes the earlier series, B.S. 1525–1537, issued in 1949. The standards for wrought materials have been regrouped so that one document applies to each wrought form, as in the B.S. 1470–1477 series for aluminium and in the schedules of wrought copper and copper alloys which are in course of preparation.

The requirements for the three materials included in the earlier series of standards have been amended, and a fourth material—low carbon nickel—has been included for some forms. Code numbers have been allocated to them and are used throughout the series, but associated with the British Standard number for each wrought form. Sheet and strip material, previously dealt with under one cover, are now the subject of separate standards as different tolerances apply and low carbon nickel is not normally supplied in strip form.

BROAD FLANGE BEAMS, UNIVERSAL BEAMS AND COLUMN SECTIONS

No. 4B : 1959. Price 8s. 6d. This new standard includes the dimensions, tolerances and properties of twenty different broad flange beam sections, forty-four universal beam sections and twenty-seven universal column sections. The universal beams specified differ in many respects from the standard steel sections shown in B.S. 4, particularly as regards the taper of the flange, which is only 2 deg 52 minutes. The column sections and broad flange beams have nominally parallel flanges and all three types of section specified have square toes. A new method of designating the various sections has been adopted. Previously, British Standard sections were designated by letters and numbers which were quite arbitrary, but this method was rarely used in industry. It was therefore decided to follow the common practice, and a section is now designated by its nominal size in inches and its weight per foot in pounds. The standard deals not only with the new universal beams and column sections, but also with the broad flange beams previously specified in B.S. 2566, therefore avoiding any possibility of ambiguity concerning which standard to quote when specifying sections with parallel flanges. The opportunity has also been taken to include requirements for some additional broad flange beams which were not being rolled at the time of publication of B.S. 2566 in 1955.

WHEEL PAIRS FOR LOCOMOTIVES AND ROLLING STOCK

No. 3117 : 1959. Part 4 : "Gibson Ring Tyre Fastening," and Part 5 : "Machining and Assembly." Price 3s. each. The dimensions of the Gibson ring tyre fastening specified in Part 4 of this publication are identical with those in Railway Clearing House Standard No. 7, and the fastening itself is of a type in normal use by British and overseas railways. Requirements are specified for the material, and the standard concludes with a fully dimensioned diagram of a cross section of the bar material, together with details of all the necessary tolerances. Comprehensive testing requirements for wheel pairs are specified for use when balancing is specified.

Part 5 of this publication specifies detailed requirements for the machining and assembly of wheel pairs for locomotives and for rolling stock of all kinds. It excludes, however, requirements for driven and coupled wheels fitted with crankpins, since these will have limited application in the future, and their inclusion would cause unnecessary complication. A number of approved alternatives for processes are provided to enable the use of any particular workshop equipment.

TOUGHENED POLYSTYRENE MOULDING MATERIALS

No. 3126 : 1959. Price 4s. In this new publication requirements are specified for three types of toughened polystyrene moulding materials consisting of thermoplastic polymers or copolymers of styrene and suitable additives. They deal with impact strength, softening point, tensile strength, elongation at break, water absorption, volatile matter and electrical properties. Methods of test are also specified.

The Physical Society Exhibition

The Physical Society Exhibition has been held this week at the Old and New Halls of the Royal Horticultural Society, Westminster, and closes at 1 p.m. to-day, January 22. A selection of the exhibits is reviewed in this article.

THE forty-fourth annual exhibition of the Physical Society was opened on January 18 by Mr. A. J. Philpot, C.B.E., M.A., B.Sc. As is customary, the exhibition was the occasion for discourses and demonstration lectures given on the evenings of the first three days. On January 18 Flt. Lt. J. Billingham of the R.A.F. Institute of Aviation Medicine, spoke on "Some Reactions of the Human Body to the Stresses of High Performance Flight." The lecture on January 19 was given by Dr. L. Essen of the National Physical Laboratory on "Atomic Time," and on January 20 Dr. D. A. Wright, of the Research Laboratories of The General Electric Company, Ltd., spoke on "Recent Advances in Solid State Physics."

An electron-beam parametric amplifier operating on the longitudinal space charge wave principle was shown by the Research Laboratories of The General Electric Company, Ltd. The effect involved is similar to that observed when a sound wave passes through a gas, the molecules responding in a series of compressions and rarefactions, and the wave travelling at a constant velocity irrespective of frequency. Similarly, when an r.f. signal is applied to a constant d.c. electron beam, it is propagated by a bunching and de-bunching effect among the electrons, but in this case in the form of two separate waves, one with a velocity slightly higher, and the other slightly lower, than the electron beam. These are the fast and slow space charge waves.

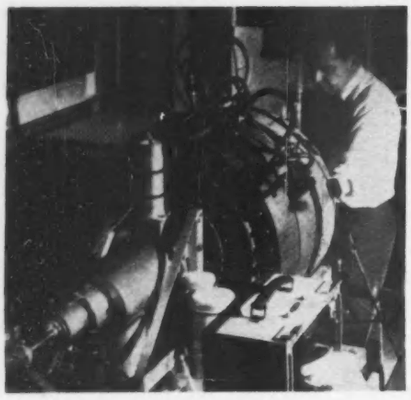


Fig. 1—Electron-beam parametric amplifier operating on space charge wave principle

Until now, all beam amplifiers (klystrons, travelling wave tubes, &c.) have been of the slow space charge wave type, where this wave is amplified as the r.f. signal grows. Noise from the cathode cannot be removed from this wave and will increase with the signal. The equipment shown (Fig. 1) is a research model for work at 2500 Mc/s; it amplifies the fast space charge wave, from which the cathode noise can be removed before the signal is applied. Amplification is caused by the interaction between the fields set up by bunching processes at the signal frequency with those of the driver (called the "pump") working at twice this frequency.

A transverse field electron-beam parametric amplifier for 200 Mc/s, the N1036 (Fig. 2) was shown by the English Electric Valve Company, Ltd., Chelmsford, Essex. This belongs to a family of amplifiers characterised by extremely low noise and high gain over a relatively wide band, the noise figure in this instance being as low as 2 dB, with a gain of 20 dB and a bandwidth of about 25 Mc/s. Tubes of this kind with comparable performances can be designed for operation at much higher frequencies.

In this quadrupole form of parametric amplifier an electron beam interacts with a radio frequency field transverse to the normal path of the beam. A beam produced by the electron gun is directed through an input coupler, a quadrupole or amplifying section, and an output coupler to a collector electrode. This beam is focused by an axial magnetic field, the field strength being such that the cyclotron frequency of the electrons and the input signal frequency are approximately equal.

Couplers of the Cuccia pattern are used for injecting and removing the signal from the beam, and the input coupler performs the additional function of removing rotational noise generated by the cathode. The input coupler and the beam can be considered as two coupled transmission lines and, ideally, all rotational noise in the electron beam is transferred to the coupler, whilst the input signal is impressed on the beam in the form of a fast wave.

In the input coupler section, the combined action of the transverse signal field and the axial magnetic field causes the beam electrons to describe helical paths with radii increasing linearly as they travel through the section. After leaving the input coupler, the electrons in the modulated beam continue to travel in helical paths of constant radii until they reach the quadrupole section, where the actual amplification takes place.

The quadrupole structure consists of four plates, equi-spaced round the beam and suitably interconnected, with four coils for tuning to the pump frequency. A pumping signal of twice the input signal frequency is applied to this structure and an alternating field is produced. This field may be resolved into two counter-rotating fields in the manner usually employed with four-pole electrical machines, each field having a frequency equal to the input signal frequency. One field component rotates synchronously with the beam and acts upon electrons of the correct phase to produce an exponential increase in the radii of their paths and hence to give linear amplification. Electrons in phase opposition to the rotating field are decelerated and the radii of their paths decrease exponentially, e.g. linear attenuation is produced. The average kinetic energy of the electrons, derived over a number of electrons entering the quadrupole section with every possible phase angle, is increased, resulting in an overall gain.

In the output coupler section, the spiralling electrons transfer their rotational energy to the output circuit and the radii of their paths is reduced to near zero.

Unlike the travelling wave tube, the input and output stages of the parametric amplifier are coupled by the beam only; the device is unilateral and is therefore unconditionally stable. In addition, excessive input signals cause the beam to spiral out and strike the tube electrodes, thus "cutting-off" the tube. Since the beam power is very low, no damage is incurred by the tube electrodes under these conditions. The "cut-off" characteristic provides complete protection to any following stages in an equipment and is of particular importance in radar applications.

Another form of parametric amplifier was seen on the stand of the Admiralty Surface Weapons Establishment. This was a broadband S-band negative conductance amplifier using a number of variable-capacitance diodes to achieve operation over a broad frequency band. Each diode is mounted in a shunt arm which is connected to a main transmission line. Each arm can be considered as a single negative conductance parametric amplifier. In this type of amplifier a source of power at frequency f_p, called the pump, is applied to a non-linear capacitor (the diode) together with the signal frequency f_s. Connected to the diode is a circuit tuned to the difference or "idler" frequency $(f_p - f_s)$ which is generated by the mixing of the signal and pump frequencies in the non-linear capacitor. The capacitor is an energy storage element with little loss, and power from the pump is converted to power at the signal and idler frequencies. When the signal and idler circuits are tuned to resonance, the admittance to the signal is a negative conductance. The main transmission line is then loaded with a number of small negative conductances spaced at a quarter of the signal wavelength apart (this being the spacing between the shunt arms). Each negative conductance results in a small increase in gain of the signal. Reflections from the negative conductances cancel to a first approximation because of the quarter-wave spacing. The gain from

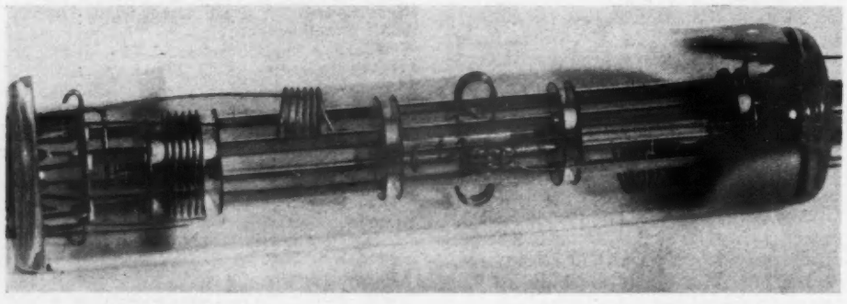


Fig. 2—Construction of electron-beam parametric amplifier, showing input and output couplers and quadrupole amplifying section

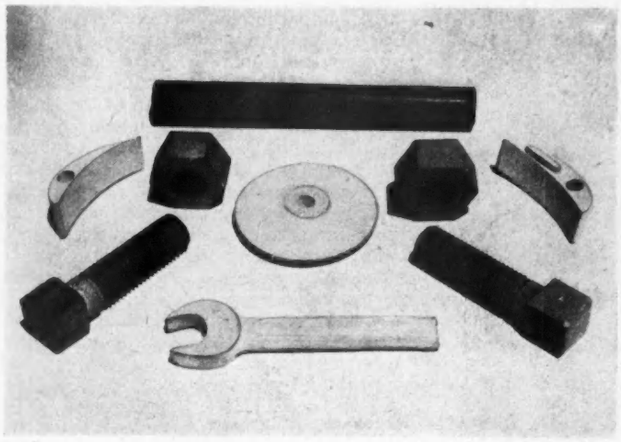


Fig. 3—Silicon nitride components ; in the centre is a thermal shock test piece

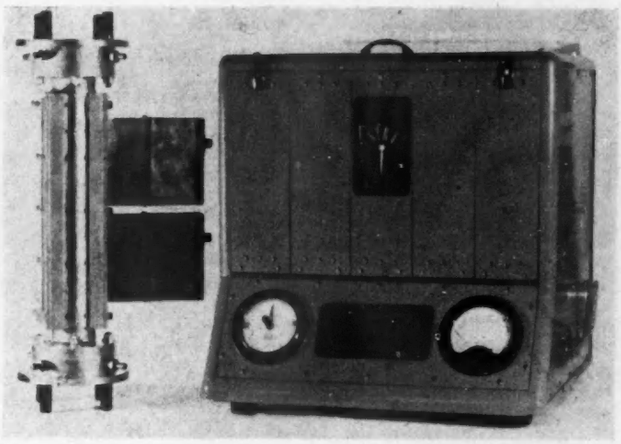


Fig. 4—Ultrasonic flowmeter, showing transducers fitted to a 2in pipe

each diode is deliberately limited to achieve bandwidth and a number of diodes is used to obtain the required overall gain.

Also on the stand shared by the Admiralty Research Establishments, much attention was attracted by an exhibit of silicon nitride as a high temperature engineering material presented by the Admiralty Materials Laboratory ; a small pierced disc of the material was being regularly heated to bright red and quenched in water. The original requirement for which this material was investigated was to form stator blades for gas turbines operating at 1200 deg. Cent. (2200 deg. Fah.) and hence resistance to thermal shock was taken as the criterion of first importance. The material is formed by heating silicon in an atmosphere of nitrogen ; to react more than a small proportion of the silicon on the surface of the mass, silicon in the form of fine powder is used, and it is first held for, say, sixteen hours at just below the melting point of silicon. A " skeleton " of silicon nitride will then be holding the mass together, and in this state it is possible to machine the material like a metal ; when the conversion is completed by heating to a temperature above the melting point of silica, again in a nitrogen atmosphere, very little change in dimensions takes place. In Fig. 3 it is shown that shapes can be formed that would not normally be attainable with a ceramic.* A desired configuration can also be attained by moulding the powder to the desired shape, several examples being displayed that had been consolidated by hydrostatic pressure within specially shaped rubber bags.

The mechanical properties of the material are generally good, but the resistance to creep is poor. However, a virtually indefinite creep life under 1½ tons per square inch at 1200 deg. Cent. has been demonstrated by dispersing into the material 5 per cent silicon carbide. Apart from a low resistance to impact, common to ceramic materials, it has one other shortcoming in that it is attacked by molten vanadium pentoxide ; however, it is considered that this effect will be inconsiderable when the mouldings are glazed. Since it is wetted by no metals outside the platinum group, it has found applications in crucibles and thermocouple probes, and it has been used as a low-speed bearing with high temperature alloys at up to 800 deg. Cent.

For coating unglazed ceramic bodies with a continuous layer of platinum metal there have recently been developed special liquid preparations, and articles so treated were displayed by Engelhard Industries, Ltd. Layers of platinum 0·005in–0·01in thick can very readily be deposited, it being necessary to fire the body in order to burn away the vehicle in which the metal is applied. The resulting films are bonded strongly to the ceramic and are not porous. Such films have been used to protect ceramics from corrosion by, for instance, molten glass, far less of the precious metal being needed than when it is applied in sheet form —moreover, the coating can be applied at the places particularly subject to attack.

Summary of Physical and Mechanical Properties of Silicon Nitride

Chemical formula : Si_3N_4. Appearance : Light and dark grey porous body. Structure : Hexagonal, lattice constants.

	Alpha form	Beta form
a	7·748±0·001	7·608±0·001
c	5·17 ±0·001	2·910±0·0005
Theoretical density ...	3·184 g/c.c.	3·187 g/c.c.

Density can be varied between the limits 1·8 to 2·7 grammes per cubic centimetre (and possibly higher) by changes in the method of pressing the silicon compact. This corresponds to a porosity of 43 to 15 per cent.

Mechanical properties : Young's Modulus for material of density 2·2 grammes per cubic centimetre, typical value is 4000 tons per square inch at room temperature and about the same at 1000 deg. Cent.

Compressive strength : 35 tons per square inch (approximate).

Hardness : 1100 VPN.

Transverse rupture strength : Density 2·2 grammes per cubic centimetre, 5 tons per square inch at 20 deg. Cent. and 7 tons per square inch at 1200 deg. Cent. ; density 2·5 grammes per cubic centimetre, 10 tons per square inch at 20 deg. Cent. and 13 tons per square inch at 1200 deg. Cent.

Thermal properties : Coefficient of thermal expansion $2·5 \times 10_{-6}$ per deg. Cent.

Thermal conductivity 0·0037 cgs. units. Temperature of sublimation 1900 deg. Cent.

Electrical properties : Electrical resistivity (engineering quality) at room temperature (dry) $1·4 \times 10^{9}$ ohm-centimetre. A completely nitrided material, tested at elevated temperature (dry B.C.R.A.).

Temperature, deg. Cent.	Room	400	700	1050
Resistivity ohm-cm.	10^{15}	10^{11}	10^{9}	10^{6}

The ultrasonic flowmeter illustrated (Fig. 4) was shown by the British Scientific Instrument Research Association. In order that the section of the pipe shall remain unobstructed, the crystal transducers are mounted well outside the pipe and inclined so that the energy is reflected from one to the other off the far side of the pipe. Each transducer operates simultaneously, at slightly different frequencies near to 5 Mc/s, as a transmitter and a receiver, and the difference between the phase lags of the transmissions in the two directions is dependent principally on the flow velocity. It is claimed that variations in the velocity of propagation cause variations in the length of path through the liquid (gases cannot be handled) due to the refraction at entry and exit, and that these variations render the output relatively insensitive to velocity of propagation : if the fluid medium is changed, the instrument must be calibrated afresh. The principles of a simple temperature-insensitive flowmeter were detailed under British Patent Specifications in our last issue.

It is established practice in the design of electrical instruments to use hair-springs to both control the movement and carry the current to and from the moving coil. An advance on this principle was displayed by the Cambridge Instrument Company, Ltd., in the shape of prototype galvanometers in which the movement was constrained exclusively by tensioned metal bands at each end of the axis : the bands were anchored to leaf springs that maintained the tension closely constant. The elimination of jewels and all relative motion between parts in contact has rendered the movement more resistant to degradation by orders of magnitude, design to withstand 300 *g* in any direction presenting no difficulty : it is expected that longevity and reliability will be correspondingly improved. An additional advantage is that a wide range of zero adjustment is available simply by rotating one of the spring mountings.

Another refinement for dial indicators was displayed by Thorn Electrical Industries, Ltd. It is relatively easy to illuminate the scale of an instrument, but often the moving element remains inconspicuous ; while a moving scale overcomes this difficulty, it has relatively high inertia. Instruments were on show in which both the dial and the needle

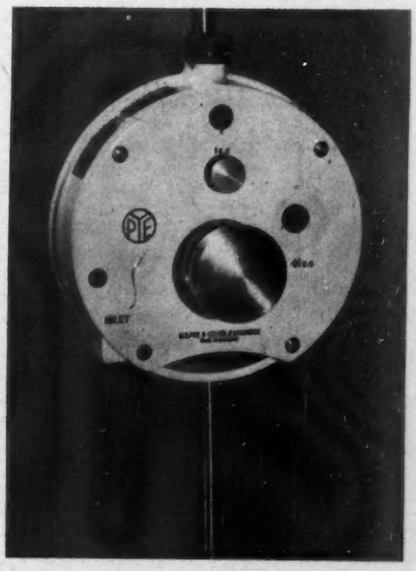


Fig. 5—Rotary burette effecting positive displacement of fluid

* This illustration and the summary of properties are taken from " Silicon Nitride—A New Ceramic," by N. L. Parr, M.I.Mech.E., F.I.M., *Journal* of the Royal Naval Scientific Service, Vol. 15, No. 1 (January, 1960).

were electro-luminescent : to obtain contrast, the needles were painted with " Dayglo " so as to appear red against the pale green or blue scale. Such instruments have, we are advised, been placed in service by Chrysler.

We illustrate (Fig. 5) a burette based upon the design of glandless pump in which a roller passes along a flexible tube, squeezing the fluid before it. By wrapping the tube into a coil of more than one turn, W. G. Pye and Co., Ltd., has evolved a dispenser with a very highly linear output : it is claimed to be devoid of any tendency to add or suck back a drop of liquid. The scale of 0·01 c.c. is attached directly to the driving knob : the scale of units advances one for every complete revolution, and can be returned to zero. It is not impossible to turn the knob backwards.

Among applications of the Hall effect was a clip-on d.c. milliammeter shown by the Solartron Electronic Group, Ltd., Thames Ditton, Surrey. This has been developed to meet the need, felt particularly by those working on transistor circuits, of a d.c. measuring instrument having a negligible voltage drop. The instrument probe, which is clipped round the lead in which current is to be measured, contains a magnetic circuit and a small Hall effect plate. Since the probe embraces the magnetic field surrounding the wire, the output from the Hall plate, which is energised from a stable source within the instrument, is proportional to the intensity of the field and hence to the magnitude of the current. This output is amplified and applied to an indicating meter with full-scale current ranges of 30mA to 1A. The instrument is fully transistorised and may be operated from a 50 c/s mains supply or from internal batteries.

Another Hall effect device was an analogue multiplier shown by the Research Laboratory of A.E.I. (Manchester), Ltd., Trafford Park, Manchester, 17. This took the form of a small plug-in unit comprising a semiconducting plate mounted in the gap of a ferrite pot core assembly, a magnetic field in the gap being derived from a current in a winding on this core. Signals in the form of currents supplied to this winding and to the semiconductor plate give rise to an output Hall voltage which is proportional to the product of these currents. This product formation can be made accurate to 0·1 per cent. Variations in ambient temperatures affect the output at a rate of 0·02 per cent per deg. Cent. The complete unit demonstrated comprised the Hall effect multiplier, transistorised drive and output amplifier.

A 1750W compact source H.P.M.V. arc discharge lamp (Fig. 6) shown by the Research Laboratory of A.E.I. (Woolwich), Ltd., was stated to be one of the most powerful enclosed compact source lamps for a.c. operation commercially available to-day. In earlier forms of this light source a problem existed in the time required for the mercury to cool after running, for until it had done so the lamp could not be restarted because of the high pressure inside the envelope. Various methods have been tried for re-establishing the arc in these conditions, such as the introduction of a third electrode to strike an auxiliary arc, the use of a Tesla coil to produce a high voltage, or the practice of keeping the lamp running at reduced output in a condition known as " simmering." In the lamp exhibited, however, re-starting when hot is accomplished by the use of an h.f. starter producing a high voltage at a high frequency which may be superimposed on the mains frequency. This enables the lamp to be shut down and restarted without delay. There is also a filling of xenon in the lamp

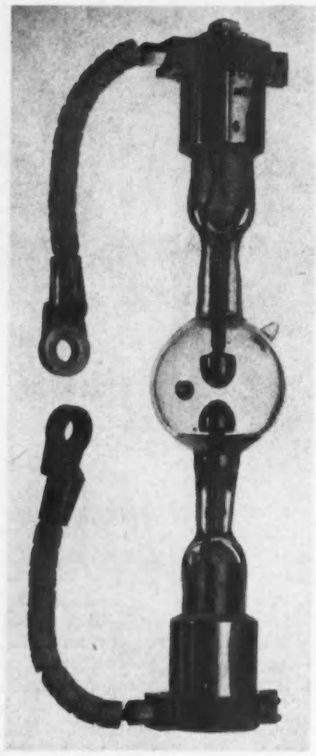


Fig. 6—1750W compact source lamp

which cuts the running-up time from cold to full output to a maximum of about five minutes. After half a minute from switching on, the mercury on the bulb begins to clear and a useful amount of light is produced. A further effect of the xenon filling is that it enables the power input to be increased without causing sputtering of the electrodes. The extremely bright and small size of the arc (35,000 stilbs per $\frac{1}{16}$ square inch approximately) and the relatively high output in the long-wave ultra-violet region make it of interest in two main fields of application. The small bright arc facilitates its use with optical systems and enables a satisfactory beam to be obtained from reasonably small and cheap reflectors. Searchlights and high bay illumination are suitable applications. The high ultra-violet output offers considerable advantages for such applications as fadeometers and photogravure work.

Salford Electrical Instruments, Ltd., showed a gamma-ray level indicator equipment which was originally developed for the National Coal Board to provide remote indication of the level of coal within pithead and underground bunkers, but various kinds of γ-source and detector heads have been developed which allow it to be used for a variety of other industrial applications involving both solids and liquids. A suitably shielded radioactive source projects a beam of gamma radiation which produces a relatively high count rate output from a detector unit placed within the beam at the required distance. Interruption of the beam leads to some absorption of radiation by the interrupting medium and a corresponding reduction in the count rate output from the detector. By eliminating probes and light beams, the system is not liable to interference by the adherence of damp coal, dirt and mechanical damage.

Apart from the Geiger-Muller tube, the detector unit contains no valves or transistors and may be situated up to 500 yards from the control unit. The latter is fully transistorised and monitors the output from four detector units, a predetermined reduction in count from any one leading to the operation of the appropriate electromagnetic flag indicator on the front of the unit. An audible alarm may be preset to operate at any level, and a fault indication is given whenever abnormal count rate conditions exist in any channel or if a power supply failure should occur. A four-level slave indicator operated from the main control unit allows the detector/indicator distance to be increased to approximately 2000 yards ; a single-level electronic control unit is also available.

A demonstration on the same stand showed a continuous-recording dew-point hygrometer, in which a d.c. thermocouple consisting of p- and n-type bismuth telluride elements is used to cool a stainless steel mirror, which forms the cold junction strap between the elements, by the reverse Peltier effect. The mirror is maintained at the dew-point by variation of the intensity of radiation from a control lamp incident on the body of the couple. This radiation is servo-controlled by the change in reflecting properties of the mirror surface at the dew-point, which are monitored by a narrow light beam in conjunction with a photocell and amplifier. A conventional thermocouple fixed to the mirror surface is used in conjunction with a pen recorder to provide a continuous record of the mirror temperature.

Another equipment for the remote monitoring of coal bunkers giving only a yes/no " coal present " output, a mechanical level sensor, was displayed by the Coal Research Establishment on the stand of the National Coal Board Scientific Department. The device, which is simple in construction and highly immune from accidental damage, consists of a tube extending into the bunker to the point with respect to which indication is required. Along this tube a current of air is driven by a low-pressure blower, and in its passage it passes through a simple injector which draws in additional air through a branch pipe. If now the outlet is restricted by the presence of coal, the pressure at the outlet from the injector will increase and the direction of flow in the branch pipe will reverse. The signal is therefore generated by a flow direction indicator in the branch : the one illustrated, in which air enters downwards, uses a hot wire anemometer

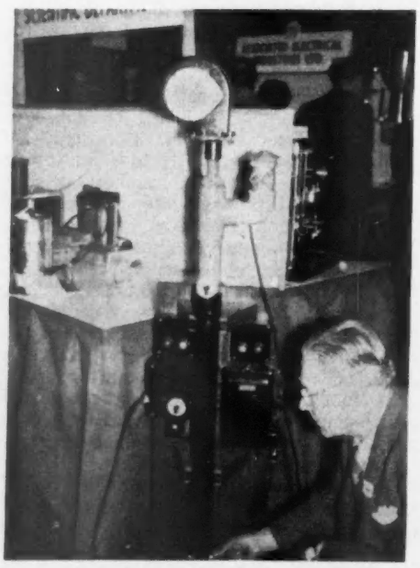


Fig. 7—Bunker level indicator sensing presence of coal

consisting of two coils of wire, one above the other : each coil is an arm of an a.c. bridge, and the downstream arm will be hotter and therefore of higher resistance. If the fan fails to deliver air, convection will cause an upward, " coal present " indication. Another detector is a simple flap switch, which also is arranged to fail to the safe indication such that the bunker is not overfilled. The indicator, which is fully transistorised, is being manufactured by John Davis and Son (Derby), Ltd.

A revolutions per minute indicator for spark ignition engines which operates by detecting the pulse repetition rate of h.f. pulses from the ignition coil was shown by British Physical Laboratories, Radlett, Herts. This instrument operates from the normal car battery and is stated to have been made independent of battery voltage changes by the incorporation of a zener diode stabiliser. Only three leads are connected to the instrument, two going to the battery and the free end of the third being coiled round the insulation of the high tension lead to form a capacitative pick-up. Pulses picked up by this means are used to trigger a transistorised monostable oscillator, the variation of the repetition rate with changing engine speed causing the mark/space ratio of the oscillator to change. The oscillator output voltage is rectified in a circuit which simultaneously clips the amplitude of the square waves to a constant level. In this way a resultant level of d.c. proportional to engine speed is obtained and operates a meter with a 270 deg. scale. All electronic components are incorporated in a printed circuit fitted into the indicator case, which measures 3½in in diameter by 2½in deep. By using an oscillator instead of operating the indicator directly from the pulses in the high tension lead, spurious operation from other h.f. sources is avoided. The indicator is being marketed by Crypton Equipment, Ltd., Bridgwater, Somerset.

A demonstration on the stand of E.M.I. Electronics, Ltd., showed a new vidicon camera tube with storage characteristics operating in a 625-line closed circuit television system for displaying transient phenomena on an oscilloscope. This vidicon tube has a specially prepared photo-conductive surface with integrating and storage properties. Persistence of the image is about a minute. Tubes of this kind can be used for systems conversion, for example, to present a radar picture as a bright, stationary television display. Such a picture might be useful in airport control, enabling a situation as recorded on a P.P.I. tube to be studied in normal lighting and with all aircraft visible simultaneously.

Specimens of electronic apparatus being contributed by the Mullard Research Laboratories for a stellar interferometer under construction for Sydney University were shown on one of the stands of Mullard, Ltd. The interferometer will enable the angular diameter of a star to be computed, using the fact that the intensity of the light emitted from a star has fluctuations within the frequency band 5–100 Mc/s. (These fluctuations are distinct from apparent fluctuations due to the earth's atmosphere, which occur at a frequency below 4 Mc/s.)

The instrument consists, in essentials, of two mirrors, each about 10 square metres in area, situated about 200 yards apart on a rotatable circular track. Light received by the mirrors is focused through a narrow-band optical filter on to special photo-multiplier tubes capable of sensing the high fluctuation rates involved. Signals from the two photomultipliers are amplified by distributed amplifiers providing a gain of 40 dB, and the instantaneous outputs of the amplifiers are multiplied together. Any correlation between the two outputs will result in a d.c. signal, the value of which depends on the degree of correlation. Correlation measurements are integrated over a period of several hours, and the final result, together with other known data, enables the angular diameter of the star to be calculated by a computer. Contributions by Mullard, Ltd., to the interferometer comprise the whole of the correlation measuring equipment, together with items of test apparatus. Demonstrations at the exhibition showed the distributed amplifiers, a part of the phase-measuring unit which measures the phase of the signals passing through the amplifiers, and a timing unit which exercises overall control over the entire instrument. The latter employs six high-speed trochotron counting tubes.

Transistors in Discharge Lamp Circuits

An official communication from the staff of the Research Laboratories of The General Electric Company, Ltd., entitled " The Application of Power Transistors to the Operation of Gas Discharge Lamps from D.C. Supplies," was presented to the Utilisation Section of the Institution of Electrical Engineers on January 14. The authors are I. F. Davies and D. Dunthorne. We abstract below some particulars of transistor circuits used with low-pressure, hot cathode fluorescent tubes, particularly for transport lighting.*

Up to recent times the operation of fluorescent tubes from d.c. supplies was attended by a high ballast power dissipation and loss of light output due to electrophoresis—the migration of positive mercury ions to the cathode ; furthermore, it was impossible to operate these lamps directly from d.c. supplies as low as 24V, and for such applications it has been necessary to use d.c./a.c. inversion equipment.

During the last two years the development of self-driven inverters, using germanium power transistors, has eliminated all moving components. Transistor inverters can be designed to operate from any d.c. supply from about 12V up to several hundred volts. These inverters can be associated with a single fluorescent tube and ballast or can be constructed as a power pack to supply a.c. power to a number of separate lamp-and-ballast combinations.

Circuits for the operation of fluorescent tubes at frequencies up to 1 kc/s have been in use for many years, mainly in transport installations. As the operating frequency is increased, some of the lamp parameters change. This is especially true of the lamp voltage, which changes from a square to a sine waveform. This is brought about by the ionisation in the lamp approaching a steady value as the frequency increases, and thus causing the lamp dynamic characteristic to approach a straight line at frequencies of 5 kc/s and greater. With a sine-wave lamp current, as is obtained with a choke ballast below 1 kc/s, and with choke and capacitor ballasts above this frequency, this results in an increased lamp waveform power factor and an increased luminous efficiency. Other contributing factors are lower cathode losses and greater efficiency of production of the ultraviolet radiation which excites the lamp phosphor. There appears to be little advantage in using supply frequencies greater than about 20 kc/s, since the efficiency/frequency curve levels off at this point.

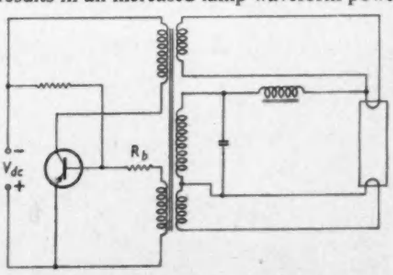


Fig. 1—Single-ended sine-wave inverter

The circuit of a typical class B sine-wave integral inverter is shown in Fig. 1. The inverter is a self-driven tuned-collector oscillator, and the load consists of a switchless-start fluorescent-tube circuit having uncompensated lamp cathode heating derived from windings on the oscillator transformer. The overall theoretical efficiency of such a circuit is 78 per cent, but in practice the efficiency is between 50 and 55 per cent.

A better efficiency is obtained by driving the oscillator into class C conditions. This may be most conveniently done by connecting a capacitor across the base resistor, R_b. The degree of class C operation may be increased, with corresponding increases of efficiency, until the peak collector current, which will increase with decreasing conduction angle, reaches the maximum specified for the transistor.

The basic single-ended common-emitter tuned-collector circuit has already been described. Where the negative side of the supply is earthed, a configuration which permits the transistor to be bolted directly to an earthed metal plate without the use of insulation washers is used. This is the common-emitter, earthed collector circuit.

The circuit of a typical push-pull sinusoidal inverter is shown in Fig. 2 ; it has a common biasing circuit, C_B, R_B, which means that the transistors must be fairly well matched in gain. A greater variation of gains can be tolerated at the expense of extra components by using two separate biasing circuits, one in each transistor base lead. The advantages of push-pull over single-ended operation are : (*a*) Twice the power output for a given direct supply voltage ; (*b*) Improved lamp-current waveform, owing to the greater symmetry of the circuit ; (*c*) The load may be disconnected without excessive voltage swings occurring.

The power transistors available in this country are designed for sine-wave inverter operation on direct voltages up to a maximum of approximately 30V. For operation on higher voltages, or where the normal

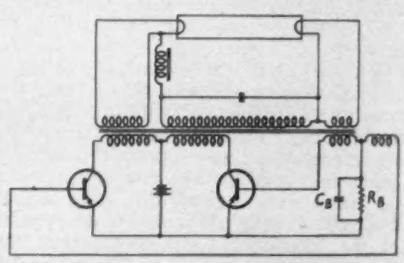


Fig. 2—Class C push-pull sine-wave inverter

* Now with Philips Electrical, Ltd.

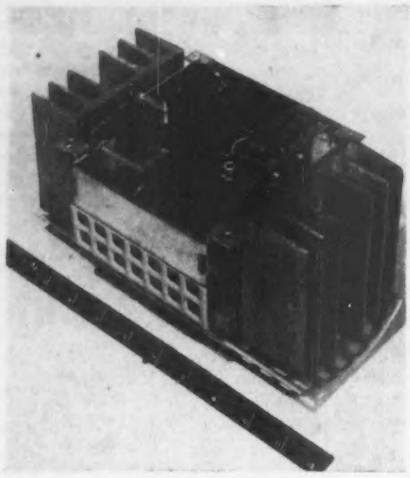


Fig. 3—A 40W transistor-inverter for British Railways using the circuit of Fig. 2

low-voltage supply is subjected to high voltage pulses, transistors may, with suitable precautions, be connected in series. This applies to both single-ended and push-pull inverters, and a typical single-ended circuit for operation on a 60V d.c. supply

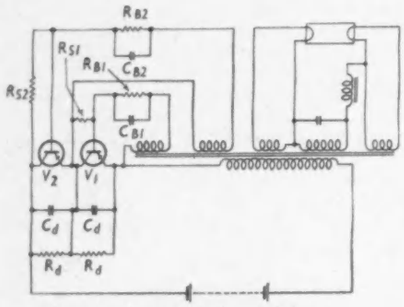


Fig. 4—Class C single-ended inverter

is shown in Fig. 4. The base resistors, R_{B1} and R_{B2}, as well as adjusting the drive on the transistors, ensuring minimum collector-emitter voltage at the peak of the conducting half-cycle, also affect the relative sharing of the voltage appearing across the transistors in the non-conducting half-cycle. The transistors are bridged by voltage-dividing networks C_d and R_d, which will supply any out-of-balance transistor current.

The connection of the starter resistor, R_{S1}, directly to the collector of transistor V_1 instead of to the negative side of the supply ensures approximate sharing of the direct voltage should the inverter fail to start. The starting resistors also provide some degree of negative feedback, which allows a little wider tolerance in matching the transistor gains. Inverters of this type have been made to operate from direct voltages up to 140V.

Another method of operating inverters on direct voltages greater than 30V is to use the "split-battery" type of inverter. The transformer primary is connected between the junction of the two transistors, and either to a "half-voltage" tapping on the battery or to the mid-point of a voltage-dividing network. The transistors have the same peak current and voltage stresses as in the series circuit, but the circuit has the advantages of push-pull operation and automatic sharing of the direct voltage between the transistors. Against this, only half of the available voltage is applied to the primary of the transformer, and consequently the step-up ratios are higher.

Royal Mail Liner "Amazon"

NAMED and launched on July 7, 1959, by H.R.H. The Princess Margaret, the liner "Amazon" successfully completed sea trials and sailed this month on her maiden voyage. The liner, the first of three ordered from Harland and Wolff, Ltd., has been designed for the South American service of Royal Mail Lines, Ltd., calling at Vigo, Lisbon, Salvador, Rio de Janeiro, Montevideo and Buenos Aires. The ship, of which we reproduce a photograph, has the following principal particulars.

Length overall	584ft
Length between perpendiculars	540ft
Breadth moulded	78ft
Depth moulded to upper deck	41ft
Gross tonnage	20,350
Passengers :	
1st class	107
Cabin-class	82
3rd class	275
Insulated cargo	435,000 cu. ft.
General cargo	45,000 cu. ft.
Service speed	17½ knots

There are four complete steel decks, namely, promenade, shelter, upper and main, together with lower and orlop decks in the holds and subdivision is effected by eight watertight bulkheads. Above the promenade deck is a separate deckhouse providing accommodation for the deck officers, a suite for the captain and navigating equipment, and the main superstructure, consisting of the upper promenade, boat, lido and observation decks.

Single-, two- and three-berth cabins, each with bath or shower, for the 107 first-class passengers, are arranged on the upper promenade and promenade decks and amidships on the shelter deck. Aft of the shelter deck accommodation is the first-class entrance and forward is the restaurant which extends for the full width of the ship and seats 120 at tables for two, four and six. The public rooms are on the lido deck, there being a lounge and verandah forward and a gallery to starboard, leading to the smoke room, aft of which is the lido cafe and swimming pool. To port and starboard of the house are covered promenades and additional promenade space is provided on the observation deck, which is laid out for games.

For the eighty-two cabin-class passengers there are single-, two-, three- and four-berth rooms, located aft to starboard on the shelter deck and to port on the upper deck. Forward of the shelter deck accommodation is an "L"-shaped restaurant in which there are tables to seat two, four or six, the total seating capacity being 114. There is a covered promenade space at the aft end of the upper promenade deck and below, on the promenade deck, is the lounge with cocktail bar to port and library to starboard. There is a swimming pool aft of No. 4 hatch.

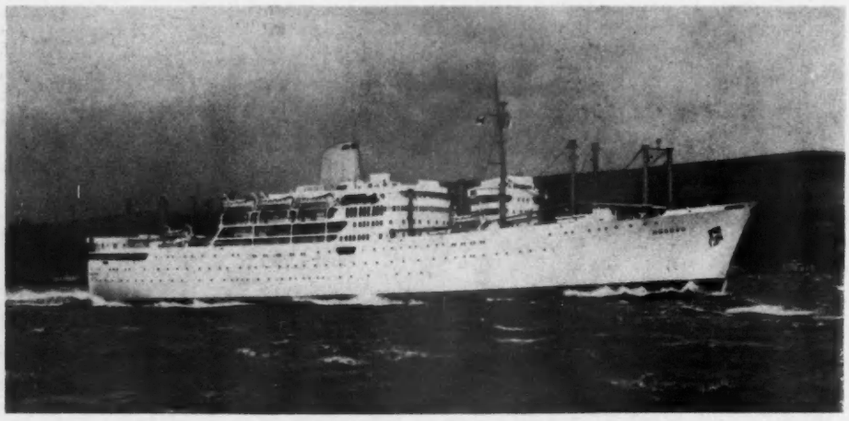
The third-class passengers have their two-, three- and four-berth cabins aft and to port on the upper deck and also aft on the main deck, and there are promenade spaces aft on promenade and shelter decks. To port on the latter deck are the restaurant, lounge and smoke room, and there is a swimming pool located on the docking bridge.

Accommodation for the crew is arranged to port and starboard of the casings on the main deck, forward and aft to starboard on the upper deck, with seamen and greasers on the shelter deck forward. Engineer officers have their cabins in a house on the boat deck.

The whole of the passengers' and crew's accommodation is fully air conditioned and the ship is equipped with Denny-Brown stabilisers. The air conditioning system, manufactured and installed by Thermotank, Ltd., has a refrigerating capacity of 5,000,000 B.Th.U. per hour, and employs twenty-three air conditioning units equipped with fin-tube heat exchangers. In winter a calorifier heats the brine, normally used as a cooling medium, so that the heat exchangers function as preheaters. When the units act as air heaters the humidity is automatically controlled. Galleys, pantries and the various preparing rooms are on the upper deck and service to the first and cabin-class restaurants is by four reversible escalators, and to the third-class saloon by two lifts, while there is one lift for cabin pantry service. Other lifts include one for the first-class passengers, one for the engineer officers, and one for baggage. Automatic telephone equipment is provided and consists of a ninety-line exchange for the passengers and a fifty-line exchange for the use of the ship's personnel.

There are three insulated holds and associated 'tween decks forward of the machinery spaces and aft of them are two orlop and lower 'tween deck insulated cargo spaces. About 4200 tons of chilled meat can be carried and a proportion of the space is available for other produce, according to seasonal demands. Two chambers can be maintained at −5 deg. Fah. Two 15-ton, four 10-ton, two 7-ton and twelve 5-ton derricks powered by twenty electric winches handle the cargo, while for handling the anchors there is an electric windlass incorporating two capstans. All the deck machinery is equipped with the Ward-Leonard system of control. For life-saving there is one Class B motor-boat, two accident boats and seven lifeboats, fitted with hand propelling gear, all constructed of aluminium alloy and carried under gravity davits.

For propelling the ship, maintaining a service speed of 17½ knots, the ship is powered by two Harland and Wolff single-acting, pressure induction, two-stroke, opposed piston, direct reversing engines, each having six cylinders of 750mm by 2000mm combined stroke. The engines are arranged for airless injection of heavy fuel and, when required, diesel fuel, and are conservatively rated to develop the required service power at 110 r.p.m. Air for pressure induction and for scavenging is supplied to each engine by two exhaust gas turbo-blowers,



Royal Mail Liner "Amazon"

and there are two electrically-driven auxiliary blowers per engine for starting and manœuvring and also for use during prolonged periods of slow running. The bedplate, which incorporates the thrust block in its after end, and the frames are fabricated. Both cylinders and blowers are cooled by fresh water circulated in a closed system, while the upper and lower pistons are cooled with oil from the lubrication system.

There are three reservoirs containing starting air for the main engine and an emergency air reservoir for starting the alternator engines. An electrically-driven air compressor charges the reservoirs while a diesel-driven unit is provided for emergency purposes.

Two Nelvin silencer boilers taking the engine exhauts gases are sited in the lunnel and two Nelvin vertical cylindrical thimble-tube oil-fired boilers are mounted in the casings. To meet the demands for electrical energy there are four Mather and Platt 750kW, 450V, three-phase, 60 c/s alternators driven by Harland and Wolff diesel engines and arranged two to port and two to starboard in the engine-room. For emergency and harbour use a Mather and Platt 400kW alternator powered by an Allen pressure-charged diesel engine of 615 h.p., running at 720 r.p.m., has been supplied. The main switchboard, manufactured by the shipbuilders, is of dead front design suitable for three-phase, three-wire system of distribution at 440V, and for the parallel running of all alternators. Ventilation of the engine-room is effected by six 45in diameter Thermotank supply fans.

The refrigerating machinery, supplied by J. and E. Hall, Ltd., consists of : five eight-cylinder Refrigerant 12 Veebloc compressors coupled to 200/143 b.h.p. motors, one six-cylinder Refrigerant 12 compressor coupled to a 35/23 b.h.p. motor and a smaller six-cylinder unit driven by a 6 b.h.p. motor.

Generator Plant for Transformer Tests

TO provide increased capacity for testing transformers up to 200MVA two new testing generators have been installed and commissioned recently at the works of Hackbridge and Hewittic Electric Company, Ltd., Walton-on-Thames, Surrey. The equipment consists of two identical motor-alternator sets, a step-up transformer and ancillary apparatus. With this arrangement the company has now available a nominal capacity of 30MVA at any voltage from 20kV to 50kV at any power factor from 0·1 to 0·01. A full-load short-circuit heat run can, therefore, be carried out on transformers up to approximately 200MVA, and the capacity of the driving motors is such that, with the addition of capacitors across the alternators, even larger transformers can be tested under full current conditions.

Power is taken from the local 11kV supply to the factory and is fed to the two sets through a p.i.l.c.s.w.a. three-core cable to the generator house. Each motor is a 2000 h.p., 1500 r.p.m. synchronous machine with two pedestal bearings and a direct-coupled exciter, and is arranged for auto-transformer starting. A vernier coupling is fitted between the motor and alternator to permit physical phasing. Both motors and alternators are self-cooled by rotor fans. Each control cubicle has a motor-field regulator, field-shorting switch and discharge resistance, with instruments showing line voltage and current as well as excitation current, and a synchrometer is included.

Motor Alternator Sets

The motor-alternator sets (illustrated here) are housed in a separate building about 150ft from the test enclosure. This building is equipped with a 30-ton overhead electric crane, extraction fans in the roof, and fluorescent lighting. The supply and output cables together with all the control cables are housed in trenches and ducts within the foundations.

There is a common lubricating system for both sets ; it includes a 750-gallon sump tank with thermostatically controlled heaters and a water-cooled oil heat exchanger. Arrangements are included to heat and circulate the oil through the bearings before starting, and to cool it when running. To reduce the starting torque and current, all bearings are fitted with individual motor-driven jacking pumps, and the starting switch is so arranged that it cannot be closed until the main oil pump as well as the jacking pumps are running.

The main oil pump is driven by a d.c. motor, the supply for which is obtained from a rectifier. The 400V 50 c/s supply for this rectifier as well as the supply for the jacking pump motors, ventilating fans, &c., is from an auxiliary 11,000/400V transformer coupled by an isolating switch to the generator house 11kV supply cable. These ancillary supplies are thus independent of the general works supply.

In the unlikely event of failure of the 11kV generator house supply the rectifier supply to the d.c. pump motor would fail but the motor would then be supplied from a 230V battery which is kept floating across this rectifier supply. This precaution is necessary because these motor-alternator sets take about forty minutes to run down from full speed to stop, and in that time the bearings would overheat to breakdown if the full volume and pressure of oil were not maintained. The generator house lighting, oil heaters, and the trickle charger for the 230V battery are taken from the general works low-voltage system.

Transformer

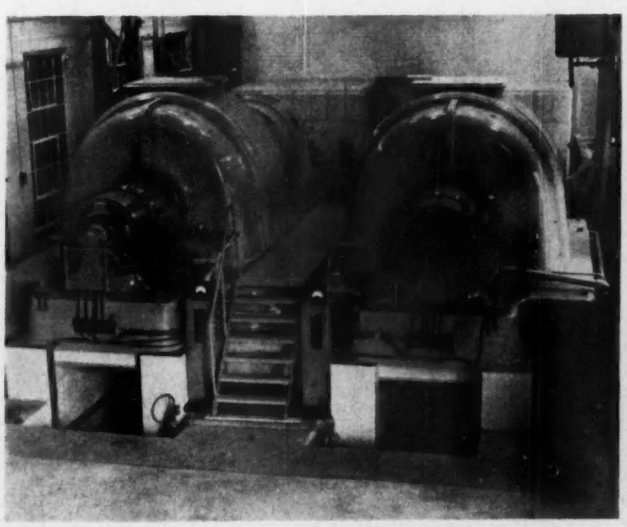
The output from the alternators is fed through single-core p.i.l.c. cables to a transformer house and, via isolating switches, to two separate primary windings of a water-cooled transformer having an output to match the machines. This transformer (illustrated here) has three secondary windings per phase, two (each of 450A capacity) arranged in series-parallel and the third, a tapped winding of 900A capacity. With this arrangement, supplies at any voltage from 20kV to 50kV in 2·5kV steps can be supplied to the terminals of the transformer on test. The output side of the transformer is always star connected, the neutral being earthed through the primary windings of the metering current transformers which are in each phase.

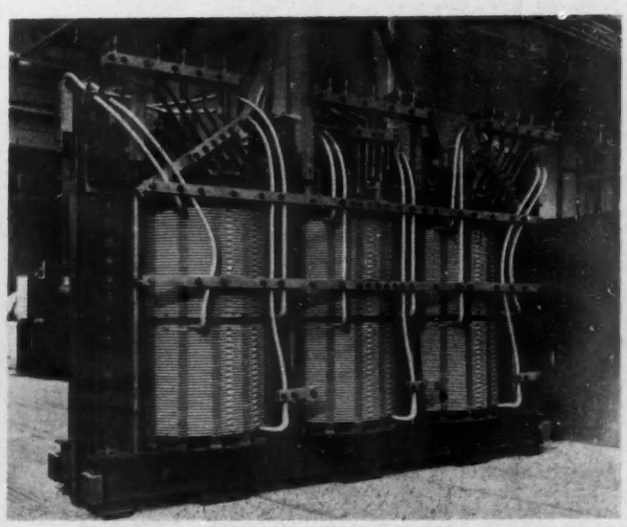
The busbars to the test area are in the form of copper tubes mounted on pin-type insulators, and an isolating switch is included in this supply circuit, operation of which is under the immediate supervision of the testing staff in a control gallery situated in the test area. From this gallery the output of the alternators and the high-voltage testing supply is controlled through push-buttons which operate the exciter field regulator, and the opening and closing of the switches in the alternator output circuits.

Controls

For each alternator set there are three essential meters included on the test control panels to give indication of the current taken by the alternator stators and rotors, and the stators of the motors. The current limit on any one of these meters determines the maximum power that can be taken from the alternator set. When the two machines are operated in parallel the alternator currents are kept equal by means of the push-button field controls. The controls for the motors are in the generator house, but once the machines are started the loading and control of the alternators is in the hands of the testing staff at the test area, and only the control of the power factor of the load on the 11kV system is effected in the generator house.

Overload and fault protection are provided for the motors and there are alarms and trips for such items as lubricating oil temperature and pressure, and transformer water and oil flow; Buchholz protection and transformer oil and winding temperature indication are also provided.





(Left) Two new motor-alternator sets for transformer tests at Hackbridge and Hewittic Company, Ltd. works, Walton-on-Thames. The starting cubicles are in the background. Full-load short-circuit heat runs can be done on transformers up to 200MVA : higher ratings can be accommodated by connecting capacitors across the alternator terminals. (Right) The output of one or both motor-alternator sets is fed into a transformer, the core and coil assembly of which is shown here. There are three secondary windings per phase : two, each of 450A capacity, arranged in series-parallel ; the third, a tapped winding of 900A capacity

Hunterston Nuclear Power Station

THE accompanying pictures show the present stage of progress on the 320MW nuclear power station which is being built at Hunterston, Ayrshire, by The General Electric Company, Ltd., for the South of Scotland Electricity Board. Although site work on the reactor pressure vessels and steam-raising units was at a standstill from the middle of September, 1959, until the beginning of the new year, rephasing of the construction programme has enabled work on the rest of the station to be continued without undue interruption.

Except for a period in the later part of 1959 the 300-ton " Goliath " crane has been in routine operation, its main use being for the movement of precast concrete units for both reactors. On the prefabrication apron between reactor B and the steam-raising-unit fabrication workshop, and on two other aprons using the permanent-workshop foundations, the various courses of the pressure vessel for reactor A are almost complete under their temporary covers. The bottom head and support course of this pressure vessel have been welded together and the whole unit is almost ready to be lifted by the "Goliath" crane, turned over, and placed inside the biological shield. There it will be welded to the outer skirt support which is already in position. The second, third, and fourth courses, and the top head, are also substantially complete, while the inner shell is far advanced. The support grid (7ft deep and weighing 340 tons) for the reactor core was delivered to the site in seven sections, welded together upside down, and then turned over by the " Goliath " crane for completion before lifting into the pressure vessel.

In the special fabrication workshop, the first three steam-raising units for reactor A are well advanced, while the remaining five are at various earlier stages. All the welds on these shells, and on the reactor pressure vessels, are 100 per cent X-ray tested and any faulty welding is rectified before stress relieving and pressure testing. Stress relieving of the shells will be done by means of hot flue gases, and the furnace for this work has been built in the workshop. Each shell will be pressure tested hydrostatically, immediately after stress relief, and the cradle that holds the vessel during both processes has been designed to carry the additional weight of the water used for the pressure test.

A recent addition to the temporary buildings on site is that housing the degreasing plant, where the protective coating on the steam-raising-unit tubes will be removed and the tubes placed in sealed containers ready for erection under clean conditions.

Civil engineering work on the reactors has proceeded with minimum interruption. On reactor A, the main walls of the biological shield are complete, and on either side of the service-machine hall concreting has reached a height of 196ft above datum. Scaffolding has been partly removed from two of the quadrants. The structural steelwork, and most of the concrete floors of the reactor building (on the turbine-hall side) are complete, and the steelwork of the exit building (on the other side) is far advanced. Spaced round the outside of the main structure are the eight plinths for the steam-raising units ; the plinths are now finished, and concrete floors linking them together and to the biological shield are ready to receive auxiliary equipment. Inside the biological shield most of the shield-cooling platework is now in position.

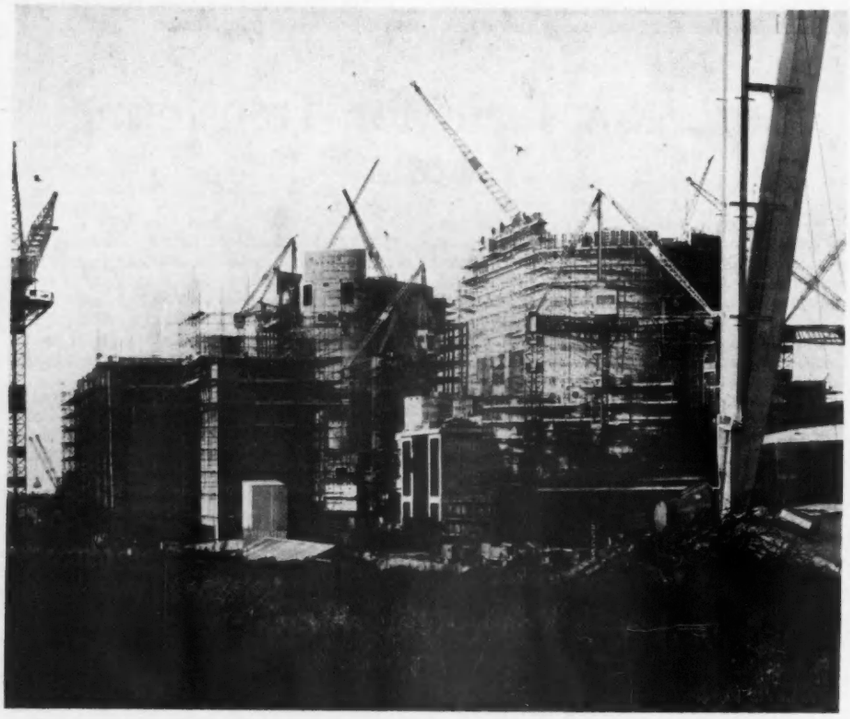
The biological shield of reactor B has reached a level of +134·00ft, and the bottom shield concrete has been poured. Seven of the steam-raising-unit plinths are complete, and the last is nearly finished. The shield-cooling platework has been installed here, and a start has been made on the steelwork of the reactor building.

Stacked near the reactors are the precast concrete beams which will form the main roof structures for the biological shields. Over 150 beams have been prepared, the heaviest ones weighing over 300 tons.

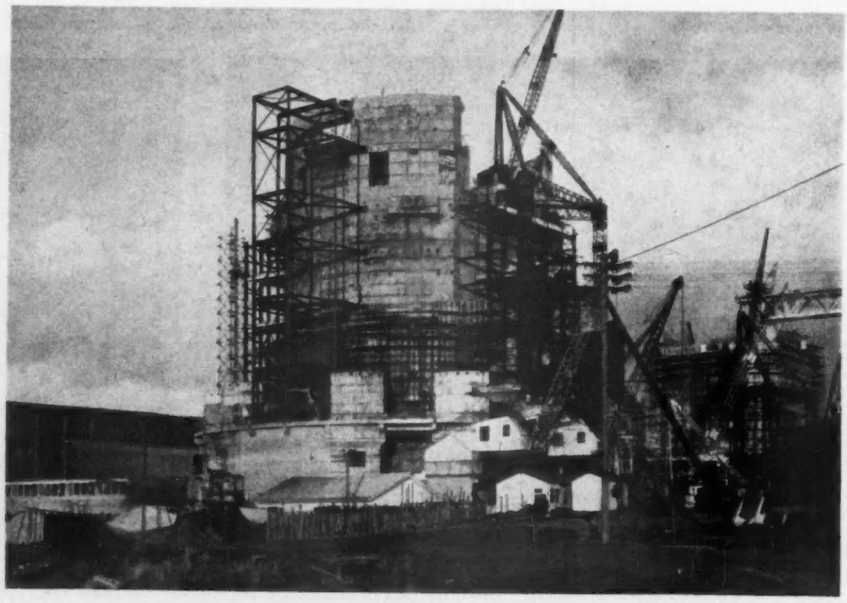
In the turbine hall, the six blocks for the 60MW turbo-generators are finished. Erection of the main steelwork of the hall, begun at the end of 1958, is complete, and much progress on glasswork, brickwork, and roofing, is evident. The cooling-water culvert manifold along the northern side of the turbine hall is complete. The overhead gantry crane has been installed and tested, and all the storage tanks for auxiliary cooling water, &c., have been placed in position. Outside the hall, the transformer foundations are ready.

About half a mile down the coast, work continues on the main pump house for the circulating-water system. The pump chambers and filter bays have been finished and penstocks installed, and the twin intake tunnels, about 70ft below sea level, have been lined with concrete. The caissons for both the intake and outfall headworks have been lowered into position, and work on the vertical intake shafts is well advanced. The permanent jetty for the intake headworks is nearly complete. Excavation of the culverts for the outfall works has been finished and work on the tunnels and headworks is progressing.

Permanent site services are well advanced : the storm-water and foul-sewage pump house is complete, the storm-water system being the first permanent work on the station to be commissioned.



The two reactors under construction at Hunterston, with the charge-machine maintenance building on the left. In front of reactor B are some of the precast roof units for the biological shield ; on the right are two of the temporary covers in which the pressure-vessel courses are fabricated



Hunterston, reactor A, with reactor B and the " Goliath " crane behind to the right. Part of the turbine hall can be seen on the left

SHORTER REPORTS

H.M.S. "Bulwark"

By Our Naval Correspondent

THE commissioning this month of H.M.S. "Bulwark" as a Commando carrier marks an important advance in Britain's preparedness for the cold and limited wars. She is the first ship of this type to be commissioned in the Royal Navy. Laid down in 1945 and built by Harland and Wolff, she was completed in November, 1954—the third of the 22,000-ton, 28-knot carriers of the "Centaur" class. The recently completed "Hermes" was originally a sister ship but her design has been so much modified and improved that she is virtually a different type of carrier. The basic design of the "Bulwark" has not been altered, though various changes and modifications have been made to make the vessel suitable for her new duties as an all-helicopter troop carrier. She is to carry sixteen Westland "Whirlwind" helicopters which will later be replaced by the gas-turbine Westland "Wessex." Four Landing Craft (Assault) will be carried at built-in gantries. Extensive offices, storerooms, and workshops are also provided on board and motor transport will be stowed on the after-end of the flight deck. The ship retains her guns, her radar and radio equipment and will be capable of directing fighter aircraft. She has also been fitted with the most extensive air conditioning system in any ship of the Royal Navy. The system is of a new type, similar to that fitted in Kuwait hospital, and covers almost all the living and working spaces. Incidentally, by virtue of the great variety of stores and equipment on board, the ship is particularly well suited for providing rapid assistance in cases of civil disaster such as earthquake, typhoon and flood. After trials and working-up in home waters and in the Mediterranean in the Spring, the "Bulwark" will sail for Singapore and be based there ready for operations anywhere "East of Suez."

The Commando unit to be embarked at Devonport before she leaves the country is 42 Commando, Royal Marines, now under training at Bickleigh, Devon. This unit has previously served in the Far East as part of 3rd Commando Brigade in Hong Kong and Malaya. It consists of some 600 officers and men equipped with the latest weapons and, to enable military efficiency and fitness to be maintained, the whole unit will be based ashore at Singapore, embarking in the carrier for exercises and operations. Her primary role is likely to be in the cold war extinguishing "a brush fire" before it can spread. In limited wars of all kinds H.M.S. "Bulwark" will provide a highly mobile amphibious force, to be employed probably in connection with other forces, including those of our allies. She will also prove of great value in securing a beach and the immediate hinterland to enable the main force to land. It will be recalled in this connection that during the Port Said operations two of our older carriers, now on the disposal list, operated some twenty-four "Sycamore" and "Whirlwind" helicopters. From positions a few miles off the coast, over 400 Royal Marines and 20 tons of stores were landed in an hour and a half.

No. 848 Naval Air Squadron will provide the "Bulwark's" helicopter complement, with a squadron personnel of about 180 officers and men. This squadron was formed originally as an "Avenger" torpedo bomber squadron and did valuable work in the Pacific campaign during World War II. It was reformed in 1953 as a helicopter squadron and for four years took part in anti-terrorist operations in Malaya. The helicopters will not only be used by the Commando during initial landings but will operate tactically in the field. They will provide the surprise, mobility and flexibility to enable the Commando to be really effective, especially in open warfare or light operations. It will be recalled in this connection that in answer to a question in Parliament a few weeks ago, the Civil Lord informed the House that the Admiralty had under consideration the provision of another of our operational vessels as a second Commando carrier. But he refused to comment on a Member's suggestion that the "Bulwark" should be supported by another carrier with strike aircraft or by an assault ship carrying armour. In any event the commissioning of the "Bulwark" for her new duties emphasises the great change that has taken place since the war in the role of the Royal Marines. In the past the corps was mainly employed as part of the ship's company of large ships—manning one of the main armament turrets and some of the 6in guns—though trained as soldiers for landing from the fleet in an emergency. Under modern conditions there is less need for marine detachments in ships and the number still at sea in carriers and cruisers has been much reduced. The Commando has in fact become the most important element in the corps, available and ready to form the first troops to be landed in amphibious operations.

Centenary of Royal Institution of Naval Architects

ONE HUNDRED years ago, on January 16, 1860, there was founded—principally on the initiative of John Scott Russell, builder of the "Great Eastern"—the body known to-day as the Royal Institution of Naval Architects.

The inaugural meeting took place at the "Hall of the Society for the Encouragement of Arts, Manufactures and Commerce, Adelphi, London," now known as the Royal Society of Arts. The Institution's hundred years' activities, as exemplified in its *Transactions*, reflect the enormous strides made in ship design and construction since the days of wood, sail, iron and steam. There was relatively little scientific knowledge of ship design in 1860, so that it became the aim and object of the founders of the Institution of Naval Architects to provide a forum for informed discussion on every aspect of naval architecture. The *Transactions* of the Institution present a fascinating record of the progress made in achieving this object, formally recorded at this first meeting—"The improvement of ships and all that specially appertains to them."

An unending variety of matters "specially appertains" to the design and building of a ship so that combined with practical structural and mechanical knowledge, the naval architect must possess more than ordinary academic and mathematical skill. Shipbuilding is very much a "specified to order" industry, the diversity of world shipping requiring every vessel to be designed for a particular purpose, added to which is the whole range of warship designs. The latter is a field of activity which, with the constant support and encouragement of the Admiralty, the Royal Institution of Naval Architects has always been closely associated.

The value of a scientific institution similar to the R.I.N.A. (one of the few professional institutions to have received recognition under the Scientific Societies Act of 1843), devoted exclusively to naval architecture, has long since been recognised by other maritime countries, and similar organisations, with constitutions clearly modelled on the British original, have subsequently been established in France, America, Japan, Germany and Italy. Despite this, the R.I.N.A. has always had a notable foreign membership of its own, and has long maintained an international status and prestige.

Many distinguished men have given their services to the Institution as president for a term of several years, and the present holder of this office, Viscount Runciman of Doxford, became president in 1951, succeeding Admiral of the Fleet Viscount Cunningham of Hyndhope. Lord Runciman will be presiding over the Institution's official celebrations of its centenary this summer, which open at the Royal Festival Hall on Tuesday, May 17, followed by the reading of two papers, namely, "Warships, 1860–1960," by A. J. Sims, R.C.N.C., and "Merchant Ships, 1860–1960," by J. M. Murray, B.Sc. On Wednesday there will be an all-day visit to Greenwich and a reception and supper at the Guildhall in the evening. An all-day visit to Stratford-on-Avon has been arranged for Thursday, May 19, when the members and their guests can attend a matinee performance at the Shakespeare Memorial Theatre or visit places of historic interest. A visit to the Ship Hydrodynamics Laboratory is on the programme for Friday morning, with a choice of half-day coach tours as an alternative and the centenary meeting will close with a banquet at the Dorchester Hotel.

Metropolitan Water Board: New Works in 1959

NOTES on the progress of the new works which the Metropolitan Water Board had under construction in 1959 are given hereunder. They include one major tunnelling scheme, now nearly complete, and a large new storage reservoir. Details of both of these schemes have, however, been published previously in THE ENGINEER, and here we give progress notes only.

102*in Raw Water Main from the Thames to the Lee Valley.*—During the year tunnel driving was completed and the total length of tunnel constructed, including two experimental lengths, is 33,322 yards. The Turriff Construction Corporation, Ltd., was engaged in lining the main in tunnel and in trench with cement mortar ¼in thick, and by the end of the year this firm had completed the lining of the main in trench, some 7625 yards, and had lined 21,000 yards of the tunnel. A contract was let to Robert Hart and Son, Ltd., for the construction of a shaft head building at the Board's Barn Elms works. The installation of pumping machinery at the Lockwood shaft is in progress. The tunnel is constructed of unbolted concrete segments, using a method developed by the Board which has proved very economical.

Walton South Reservoir.—Progress has been well maintained by the contractor, W. and C. French, Ltd., with the construction of this storage reservoir, which will hold 4300 million gallons. Progress up to last June was illustrated in our issue of January 1, page 11; by mid-October, 1958, the compacted clay cut-off trench had been completed. Seventy per cent of the compacted clay core wall was placed and 82 per cent of the supporting embankments had been raised to a general level of 70 O.D. by the end of the year. The 100in internal diameter inlet tunnel was completed and work was in progress on the construction of the inlet pierhead and the jet pipelines. The outlet tunnel was driven and the forebay of the outlet tower, itself 20 per cent completed, was constructed. The 72in diameter conduit leading to the outlet tower from the centre of the reservoir was substantially completed. The concrete toe at the foot of the inside embankment was completed and work is in progress on the construction of the concrete kneelers. The contractor has devised and built a machine for placing and finishing the concrete lining on the inner slopes of the reservoir embankment and experimental sections have already been placed. When the machine is fully operational, it is expected that progress in the placing of the slab lining will be very rapid. A start was made in 1959 with the construction of the three limnological towers which will be a feature of the completed reservoir. The contract involves

SHORTER REPORTS *(Continued)*

the disposal of over 1,750,000 cubic yards of surplus materials, consisting of soil, overburden, ballast and London clay ; over 66 per cent of this quantity had been dealt with by the end of the year.

Augmentation of Supply to the Kent Area.—A general outline of this scheme was given in the review we published at this time last year. The additional pumping plant required at Shortlands pumping station was ordered in 1959 and that at Horton Kirby was put into service last July. The new plant for Lullingstone is expected to be installed early this year and a tender has been accepted for the new pumps for Sundridge, where an additional borehole has been sunk to a total depth of 195ft. Considerable progress was made in the laying of mains and making connections to the service reservoirs. J. Jarvis and Sons, Ltd., commenced work on the construction of the new 5 m.g. capacity service reservoir at Farningham in December, 1958. By the end of the year the major portion of the outer walls and the division wall was constructed ; the lower floor slab was placed ; all the main columns were cast and a number erected, and erection of formwork and concreting of the roof beams was in progress. The overflow pipes were erected and a part of the inlet/outlet main was laid.

The tender of the Turriff Construction Corporation, Ltd., for the construction of a new 5 m.g. service reservoir at Farnborough was accepted by the Board, and work is due to start.

Diversion of Staines Aqueduct.—The Middlesex County Council, acting as agents for the Ministry of Transport, commenced the construction of the Staines By-Pass Road, which necessitated three major alterations to the Board's Staines aqueduct. In the vicinity of Billet Bridge, Staines, the aqueduct is being put into tunnel and apart from making the junctions of the aqueduct to the tunnel shafts, W. and C. French, Ltd., had completed this diversion by the end of the year. At the site of the new Wraysbury roundabout the section of the aqueduct has been altered from open trapezoidal to closed circular.

Other Works.—At Kew Bridge works the construction of a 4 m.g. reinforced concrete suction and balancing reservoir was completed by John Howard and Co., Ltd. The following firms were awarded contracts in connection with the remodelling of Walton pumping station : Brush Electrical Engineering Company, Ltd. ; Denis ; Ferranti, Ltd. ; John Smith (Keighley), Ltd. ; Hopes Heating and Engineering, Ltd.; and Robert Hart and Sons, Ltd., who started work on the construction of roadways and ancillary buildings in December. The reconstruction of Crayford Well Station was completed and work on the erection of a new pumping station at Bexley is now in an advanced state.

Work by direct labour on the reconstruction of the slow sand filter beds at Hampton works was continued and fourteen beds have now been completed. The construction of a central sand washing plant, sand store and sludge bed was finished during the year.

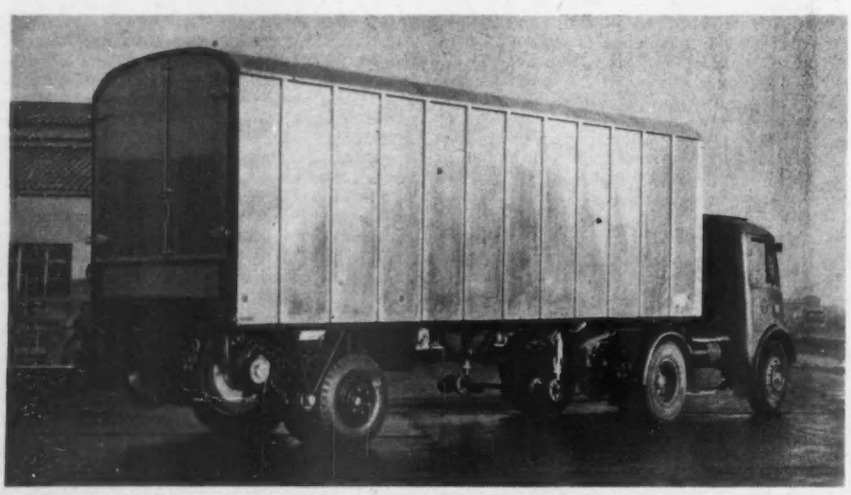
Road-Rail Freight Vehicle

MANY attempts have been made to solve the problem of interchanging freight between road and rail vehicles, which normally involves expensive handling and much loss of time. The prototype of a new vehicle designed to eliminate need for this interchange of freight is about to be tested by British Railways and it is illustrated below. This design is based upon a vehicle developed in the United States by the Chesapeake and Ohio Railway, and the prototype for this country has been designed jointly by the engineers of British Railways and the Pressed Steel Company, of Cowley, Oxford.

As can be seen from the illustration the vehicle, which has a payload capacity of 11 tons and is known as the "roadrailer," is generally similar in appearance to the normal design of road-hauled semi-trailer. Its trailing end, however, is fitted with a special road and rail wheel assembly by which the appropriate set of wheels can be lowered into an operative position to adapt the vehicle for road or rail travel. Technical details of this assembly have not yet been released but we understand that each axle is carried on a beam structure pivoted at the centre. Hydraulic jacks are used to pivot this beam structure to lower the road wheels and raise the rail wheels and vice versa in accordance with the class of duty. A special coupling is fitted at the leading end of the vehicle chassis by which it is coupled to the trailing end of a similar trailer when making up a train.

With this arrangement individual road-hauled trailers can be loaded at industrial establishments and hauled to a yard where they are coupled up into a train for high-speed rail haulage to a yard near the destination. At this yard the road wheels are let down for the trailers to be hauled to their final destinations for unloading. The system will thus combine the flexibility of collection and delivery by road with the speed of direct transport by rail.

It is announced that the first of the prototype vehicles is about to undergo trials at the Motor Industry Research Association's test track at Nuneaton, where it will be joined by a second vehicle in a few weeks time. On completion of the road tests rail trials will be put in hand between Bishop's Stortford and Braintree.



Prototype road-rail vehicle arranged for road haulage with the rail wheels at the trailing end, retracted

Portable Viscometer for Lubricating Oils

A LIGHT portable viscosity comparator has been introduced by Control Developments, Ltd., 30, Gloucester Street, Gorton, Manchester, 18, to provide a quick and accurate means of testing the condition of lubricating oils by diesel and other plant engineers. The instrument is carried in a pocket case and with it the viscosity of an oil sample can be compared with that of a reference oil of known characteristics.

The comparator incorporates in one unit a pair of rolling sphere viscometers, one of which is filled with a certified oil and has a scale calibrated at 70 deg. Fah. The glass tube of this reference viscometer contains a stainless steel sphere and its end is fitted with a gland designed to permit free expansion and contraction of the oil with changing temperatures. The glass tube for the oil to be tested is fitted on the opposite side of the graduated frame and contains a similar stainless steel sphere. A nozzle and plunger on the opposite ends of this tube are used to fill it with the test oil.

When carrying out a test the instrument is tilted to bring the spheres in the oil-filled tubes to one end and then tilted the other way so that the spheres roll down through the oil. As the leading sphere approaches the full scale mark the instrument is gently brought to a horizontal position with the sphere at rest by this mark. The position of the other sphere in respect to the graduations indicates the viscosity of the test oil. A range of standard calibrations is available for use with all grades of oil in general use. A thermometer supplied with the instrument is used when it is necessary to apply a temperature correction to a reading, simple correction data being supplied for use at temperatures other than the 70 deg. Fah. at which the reference tube is calibrated.

[Reply Card No. E1422]

DR3 Research Reactor, Denmark

WE learn that the nuclear research reactor DR3, supplied by Head Wrightson Processes, Ltd., 24/26, Baltic Street, London, E.C.1, for the Danish Atomic Energy Commission, became critical on January 17. This reactor, which is installed at the Danish atomic research centre at Risö, near Copenhagen, is of the same family as "PLUTO" at the United Kingdom Atomic Energy Research Establishment, Harwell. Like "PLUTO," the DR3 reactor has a thermal output of 10MW and a maximum neutron flux of 10^{14}n per square centimetre per second, and will be used for research into the effects of irradiation on materials. The fuel consists of stacks of dished plates of uranium/aluminium alloy clad in aluminium. The reflector is graphite and the moderator and coolant, heavy water.

By-Pass Engines

A FURTHER development of the Rolls-Royce "Conway" has been announced, for service in 1963. The by-pass ratio has been increased substantially by substituting a larger low-pressure compressor of improved efficiency and a more efficient l.p. turbine, the h.p. line being retained. The new engine, the R.Co.42, has a mass flow of 363 lb per second and a guaranteed minimum thrust of 20,250 lb compared with the 295 lb per second, 18,500 lb and 282 lb per second, 17,500 lb of the R.Co.15 and 12 respectively. Cruising at 475 knots and 35,000ft, the specific consumption is 0·785 per hour (R.Co.12, 0·874 per hour). The enlarged engine is to be used in the thirty-five Vickers VC-10 airliners on order for B.O.A.C.

Long Throw Louvres

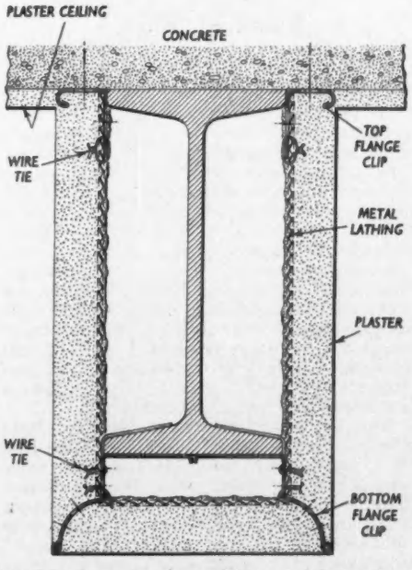
A NEW drum pattern punkah louvre, designed for use with air conditioning, heating and ventilating installations in large enclosed areas, has been introduced by the International Products Division of Thermotank, Ltd. Drum louvres have been produced for a number of years, mainly for marine use, but the improved design constructed of aluminium alloy sections has a number of advantages, particularly for land installations. In large enclosed areas, such as concourses, passenger terminals, department stores and factories, the use of the drum louvre obviates the necessity for long runs of duct work since it has a throw of 120ft and so can distribute air over a large area. The louvre provides complete control of air distribution in both vertical and horizontal planes. The air outlet is contained in a movable drum which can be rotated through 60 deg. about its major axis, while adjustable deflecting vanes in the opening give directional control at right angles to this axis. They also permit the length of throw and residual velocity of the air to be adjusted to suit particular installations. The louvres, the largest of which weighs 11 lb, are available in eight sizes ranging in length from 1ft to 3ft, and in depth from 9in to 12in, and can be mounted in either horizontal or vertical positions. Duct openings vary from 10in by 6in to 36in by 10in. Performance tables are available for each louvre at air volumes from 200 to 5000 cubic feet per minute.

[Reply Card No. E1431]

Lightweight Fire Protection for Structural Steel

A SYSTEM of fire protection for structural steel beams and columns has just been introduced by a group of firms, after a study of its economics and performance. The system is based on the use of a lightweight plaster, made of gypsum and vermiculite, which is applied to a cage of metallic mesh surrounding the steel member. Metallic corner beads or angles are fitted around the steel member and protrude beyond the mesh, thus ensuring that the stipulated thickness of plaster is actually placed. This precaution is important, since the fire rating depends on the thickness of plaster.

A typical example of a beam protected by the system—in this case with a concrete floor slab above it—is shown in the accompanying drawing. It will be seen that the bottom angles simply clip on to the lower flange of the beam, and the top angles are plugged or bedded into the soffit of the floor slab. Metal lathing is wired to the angles, which are perforated so that the whole assembly can be quickly and easily completed. Premixed plaster will be used, thus ensuring the correct quality in the plaster, which is applied as shown to the full thickness. There are alternative methods of forming the "cage" in which the plaster is laid; for instance lathing wired to mild steel formers or to vermiculite concrete blocks may be used. Stanchions may generally be treated in a similar way.



Metal lathing and mesh system for applying a given thickness of plaster round a steel beam

The commonly used fire ratings of one to four hours may be achieved by using ½in to 2½in of plaster respectively; a two-hour rating given by 1in of plaster is shown in the case illustrated. The study and evolution of this system was carried out by Frederick S. Snow and Partners, and was sponsored by the British Constructional Steelwork Association, The Expanded Metal Company, Ltd., The Gotham Group of companies (manufacturers of gypsum plaster), Mandoval, Ltd. (suppliers of vermiculite), and three plastering contractors, namely, Pollock Brothers (London), Ltd., W. J. Roberts and Sons, Ltd., and A. C. V. Telling, Esq. A brochure explaining the system in detail entitled "Lightweight Fire Protection for Structural Steelwork" is available, and last night a paper on the subject by Mr. A. R. Mackay, was presented for discussion at the Institution of Structural Engineers.

It is expected that this system will be acceptable under local by-laws covering fire protection; the development work included tests at the Fire Research Station. A considerable weight-saving over concrete-encased steelwork is possible, and though the economics of various buildings will differ in several terms a direct saving of at least 8 per cent is claimed.

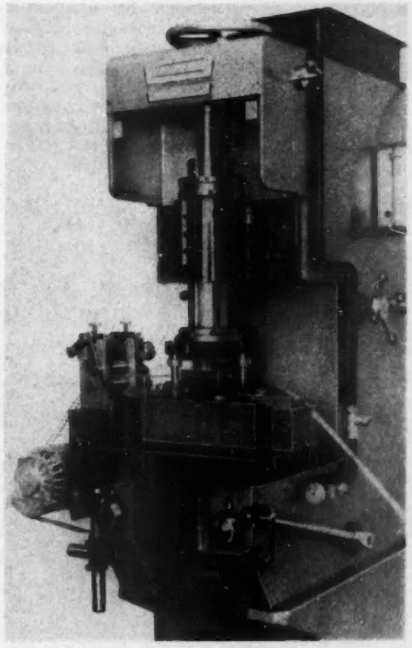
[Reply Card No. E1432]

High-Speed Press Roll Feed

IN our issue of January 30, 1959, we described in some detail the 7½-ton capacity high-speed hydraulic press made by the Norton Tool Company, Ltd., Plough Lane, Smallfield, near Horley, Surrey. This press is capable of working at speeds from 40 to 800 strokes per minute. Its makers have now developed a new design of roll feed unit to enable full advantage to be taken of its rate of stroking in the higher ranges, where conventional mechanical feeding devices have been found too slow in operation. This new feed device is suitable for use with strip of any normal weight and gauge up to 4in wide and it allows any length of progression within the machine's capacity. The feeder can be used with press tools incorporating precision progression or indexing means, such as a trigger stop or side cropping. It gives an instantaneous pick-up when progressing the strip with a sensitive control of forward torque, which is low at the point when the strip is checked and held for the pressing operation by the trigger stop or side crop in the tool.

A press fitted with the feed device can be seen in our illustration. The device comprises a pair of hardened steel rolls, the lower one of which has at one end a pulley driven through a slip belt by a ¼ h.p. synchronous motor. This slip belt is mounted between the motor pulley and an idler pulley to one side and above the roll pulley. Drive is transmitted to the roll pulley through its contact with the outer side of the belt and this arc of belt contact can be varied by adjustment of a jockey pulley. In the course of a high-speed pressing sequence, the slip belt runs continuously and slips on the roll pulley whilst the strip is halted in its passage through the rolls by the tool stops or side crop during the actual pressing cycle. By the setting of the roll spacing and the arc of belt contact, there can be adjusted the overall torque required for progression and the amount of torque transmitted whilst the strip is at rest. With these adjustments the torque transmitted when the strip movement is checked by the tool can be set light enough to ensure that there is no tearing of low tensile thin gauge material against stops in the tool. At the same time, the light pull of the slip belt drive to the lower roll enables ready alignment of pilots in the tool whilst adequate progression torque is maintained to give instantaneous pick-up on release of the strip by the tool stops. As the strip is always under a light tension, high speeds can be maintained on thin gauge materials without there being any tendency to strip flutter.

The spring-loaded top roller of the feeder is adjustable for strip gauge-spacing purposes and a two-step reversible pulley on the motor gives a choice of roll speeds. These equipments can be equally well used for either feeding in or feeding out strip in a press, and if necessary two can be used in tandem to provide a double-



High-speed hydraulic press fitted with a roll feed which makes possible operation at up to 800 strokes a minute

roll feed. They can also be used to advantage as feed-out units with guillotined short lengths of material, as each length is run fully through and cleared of the tool, leaving the press ready immediately for introduction of the next piece. A complete feed unit can be quickly and easily mounted and removed on a Norton press, enabling their economic use for relatively short runs and making it possible to use a press for general purpose work between times.

In the course of a recent demonstration with this new roll feed, we saw 1in wide 28 S.W.G. nickel silver coil being punched out to form contact blades at a rate of over 700 pieces a minute. The tool used was of two-stage design, with a trigger stop and piloting on the second stage, using a $\frac{7}{16}$in progression.

[Reply Card No. E1433]

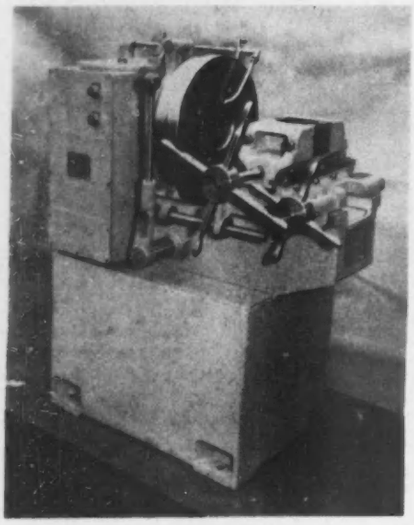
International Association for Shell Structures

A SYMPOSIUM devoted to "non-conventional processes of construction" was held in Madrid last September, and was attended by a hundred specialists from twenty different countries; more than thirty papers were read. As a result of this symposium, the International Association for Shell Structures has been formed. Its purpose is to help the development and activity of this technology. The I.A.S.S. plans to hold a colloquium on "Precast Shells" next autumn. A meeting is also scheduled to be held in September, 1961, in Delft (Holland), dealing with "Experimental Research on Shell Structures," to be followed immediately by a third one in Brussels on "Approximate Methods of Calculation." The president of the Association is Professor Torroja, and the executive council of fourteen includes Professor A. L. L. Baker and Mr. R. S. Jenkins from this country. The address of the secretariat of the International Association for Shell Structures is Alfonso XII, 3, Madrid (7), Spain.

SHORTER REPORTS *(Continued)*

Threading Machine

A THREADING machine made by Joshua Heap and Co., Ltd., Ashton-under-Lyne, illustrated herewith, is of an improved design with a capacity for screwing pipes from ¼in to 4in, and ¼in to 2in diameter bolts. Its headstock is driven by a 3 h.p. motor through a flexible coupling and pick-off gears, giving four spindle speeds of 6, 11, 21 and 38 r.p.m. when using a radial diehead and 11, 21, 38 and 74 r.p.m. with a tangential diehead. The radial diehead used with the machine has a built-in receding mechanism which allow taper threading as well as the



Threading machine for ¼in to 4in diameter pipes and ¼in to 2in diameter bolts

production of parallel threads. This diehead has lever release mechanism and it can be opened and closed whilst the machine is running. A lever release is not provided on the tangential diehead, which also has receding mechanism for taper thread screwing.

The heavy saddle of the machine carries two pairs of vice jaws for gripping the larger sizes of workpieces. A large cabinet base on which the machine is mounted contains the cutting lubricant tank and a swarf collection space. Ancillary equipment available for these machines includes tapping units, die grinding fixtures, roller steadiers, &c.

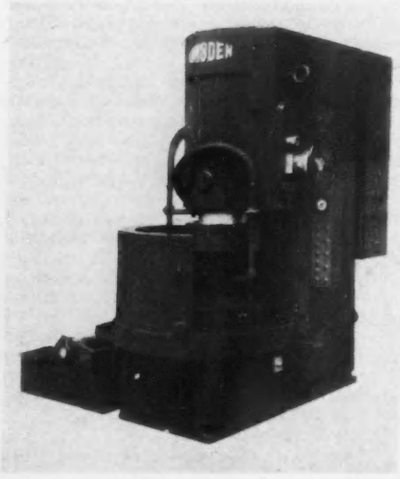
[Reply Card No. E1441]

Surface Grinding Machine

THE most recent addition to the Lumsden range of surface grinding machines is the model "90ML," which is shown in the accompanying illustration and has a 25in diameter table taking a 24in diameter magnetic table. It is used with 14in diameter segmental wheels or a 14in by 11in by 4in ringwheel, the height over a magnetic table to a segment protruding 1¼in from the wheel chuck being 8in and over the table to a new ringwheel 6¼in. The wheel has a vertical travel of 10in and the spindle ram is fitted with a new automatic feed control which is variable in ten rates between 0·004in and 0·040in per minute. The maximum drum feed at one setting, using the automatic stop, is 0·300in.

With the new automatic feed control it is possible to preset accurately the amount of stock to be removed from a workpiece. For example, if 0·050in is to be removed and the estimated ratio of stock removal to wheel wear is 10 to 1, a trip dial is set to 50+5 thousandths, i.e. 55, and the feed set for any required one of the ten feed rates. As the wheel descends the trip dial turns and shows the amount the wheel still has to feed: the feed automatically stops when the dial registers zero. A second dial provided for setting and adjusting the trip mechanism is graduated in 0·001in increments.

To prevent damage in the event of a power supply failure to the magnetic table, a relay is incorporated which, on inadvertent stopping of



Surface grinding machine with 24in diameter magnetic table

the table current supply, starts the elevating motor of the wheel spindle ram in the upwards direction and stops all other motors. Thus, the wheel is raised clear of the work before the residual magnetism has decreased sufficiently to free a component.

The spindle of the machine is driven by a 25 h.p. motor at 1075 r.p.m., and the table at 12 and 36 r.p.m. by a 1½/½ h.p. motor. A ¾ h.p. motor actuating the wheel spindle ram elevates it at 24in per minute and the spindle feed is driven by a ¼ h.p. motor. These Lumsden machines are distributed by Alfred Herbert, Ltd., of Coventry.

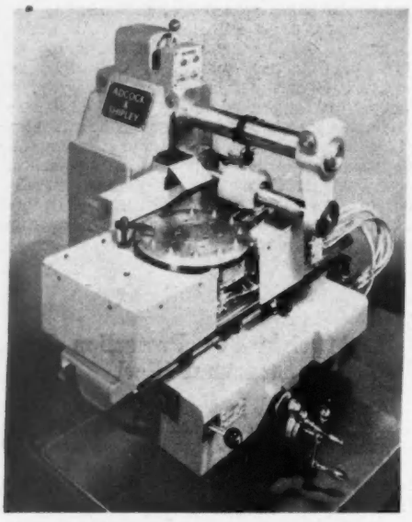
[Reply Card No. E1442]

Automatic Cycle Milling

ONE of the No. 1 air-hydraulic automatic cycle milling machines made by Adcock and Shipley, Ltd., of Leicester, has recently been supplied fitted with a special adaptation of the Bristol-Erickson indexer. On this machine, illustrated here, the operator can load two components in one position whilst two other components on the other side of the indexer table are being milled. These air-hydraulic machines normally have an automatic table cycle consisting of rapid approach, automatic change to cut feed, rapid return and stop. The table is actuated by twin air cylinders mounted in the cross slide, and the control of the feed rate during the cutting operation is carried out by a hydraulic cylinder, also mounted in the cross slide. The hydraulic cylinder acts as a dashpot controlled by a metering valve to give a very smooth cutting feed. On the machine illustrated, the control circuit was modified to give continuous cycling instead of the machine stopping at the end of each stroke.

The Erickson indexing table, manufactured in this country under licence by the Bristol Tool and Gauge Company, Ltd., of Bristol, being also air operated, is well adapted for operating in conjunction with the air-hydraulic milling machine table cycle. The components being produced in this application have two flats straddle-milled on them and four cutters, arranged in two pairs, mill two components at each cycle. The time cycle of eight seconds gives an output of fifteen components per minute. A spring-loaded wiper arm positioned between the ejection and loading stations removes the majority of the swarf from the fixture.

The loading station is followed by an idle safety station in case the operator should misload and, following the safety station, there is a checking station at which either an incorrectly loaded or an oversize component moves a lever which stops the machine. To ensure rigidity during cutting, the component and the table are



Air-hydraulic automatic cycle milling machine fitted with air-operated indexing table

automatically clamped and only released during the indexing operation.

Whilst two components are being milled those completed in the previous cycle are ejected from the table by air-operated plungers and gravitate down a chute. The table of the indexing unit can be easily changed to enable the machine to be used in the production of a number of different components using interchangeable tables complete with their clamping devices.

[Reply Card No. E1443]

Industrial Films

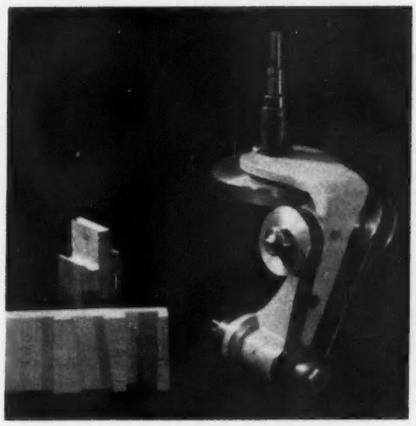
A THIRTY-MINUTE film in "Eastmancolour" with the title "Industrial Electric Heating," is available on free loan in 16mm and 35mm sizes from the Electrical Development Association, 2, Savoy Hill, London, W.C.2. The approach to the subject is on the lines of "a film within a film," the narrative concerning a film producer seeking material on electric heating who finds it by attaching himself to an instructional course at the works of a manufacturer of electric industrial heating equipment. In this way the principles of resistance, induction and dielectric heating are explained as a logical part of the story and the opportunity is given for numerous effective shots of heating plant in action, those of metal melting being particularly dramatic and colourful. Ease of control, cleanliness and ready availability of electrical heating methods are emphasised throughout the film.

Two new films have been made by Wolf Electric Tools, Ltd., Hanger Lane, London, W.5, dealing with the domestic and industrial uses of portable electric tools. The first of these films, entitled "People Like Us," describes the many and varied uses for the firm's home power tool kit. The other film, "One Jump Ahead," is designed to show the potentialities of modern electric tools for heavy production and special work in the engineering trades.

Routing Attachment

A USEFUL routing attachment which can be fitted on standard square-chisel mortising machines, and is now made by B. S. Varley, 16, Padiham Road, Sabden, near Blackburn, can be used for trenching, mitring, tenoning, &c., up to a depth of 5in in wood or plastic materials. The simple design of the attachment can be seen in our illustration, and it is made for use as a standard mortising machine without need for modification.

It has a $1\frac{3}{16}$in diameter holder shank similar to that of a standard machine chisel shank and a



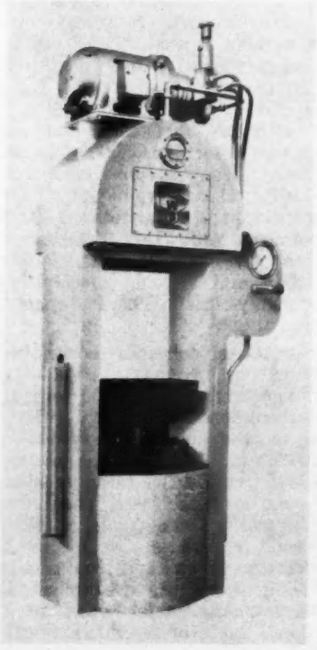
Vertical routing attachment for mortising machine

$\frac{1}{2}$in diameter driving shaft identical to that of an auger used in conjunction with a square chisel. A small universal coupling incorporated in the driving shaft assembly provides for any slight degree of misalignment in the mortising machine drive. The spindle drive is transmitted to the tool spindle through belt pulleys designed to give a final drive speed of about 12,000 r.p.m. to the cutter. The attachment takes standard routing cutters with $\frac{1}{2}$in diameter parallel shanks.

[Reply Card No. E1451]

Upstroking Hydraulic Presses

UPSTROKING hydraulic presses of 500 and 1000 tons capacity have recently been added to the range of machines made by William Jones, Ltd., 1, Fitzroy Square, London, W.1, for forging, forming and general duties. A photograph we reproduce of one of these presses shows how a clean compact arch frame design has been used to restrict floor space requirements to a minimum. The 500-ton press has a 6in stroke and a 19in by 14in table and the 1000-ton machine a 12in stroke with a 36in by 36in table. Both sizes of press have a daylight of 24in, and each standard model has an approach and pressing speed of 6in per minute with a return speed of 15in per minute. Alternative operating speeds can be specified.



Upstroking hydraulic press available in 500 and 1000-ton capacities

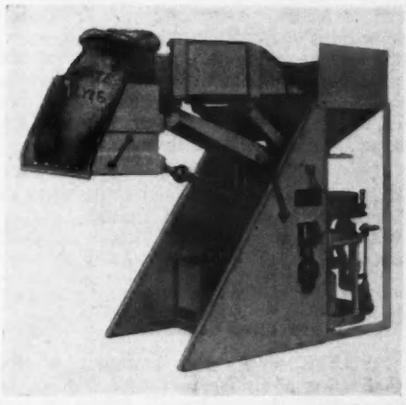
The press frame, of heavy welded plate construction, has the main hydraulic cylinder built integral with the base and an oil tank with the hydraulic power equipment built into the head. The main ram of high-grade cast iron incorporates the lower platen, which moves in guides machined in the main frame. This single-acting main ram is designed for gravity return assisted by built-in side tension springs giving the controlled return speed of 15in per minute. If required an internal ejector ram can be fitted.

Pressure fluid is supplied to the press by a single-stage high-speed pump driven by a directly coupled continuously-rated, squirrel cage induction motor. On the standard press a hand lever on the frame side controls press operation with reference to a gauge which shows the total load applied. If specified, presses can be supplied with push-button, fixed, or pendant control or foot control by pedal or bar.

[Reply Card No. E1452]

Container Raising and Tipping Machine

A MACHINE has been developed by Russell Constructions, Ltd., Russell House, Adam Street, London, W.C.2, for lifting and tipping the contents out of most forms of containers such as sacks, bins, drums, &c. As can be seen in the typical application illustrated below, the



Raising and tipping machine arranged for emptying sacks into a buffer stock hopper

machine has a rigid steel frame and its hydraulic power set is enclosed within the main structure. The containers or sacks to be emptied are placed in a cradle lowered to floor level and when a chute to which the cradle is hinged has been raised to an angle of about 70 deg. the cradle is tipped for its contents to gravitate down the chute. Containers weighing up to 6 cwt can be handled with these machines, and discharge heights between 3ft and 8ft are available.

The cradle complete with its chute section is raised by arms operated by a hydraulic ram and a second ram, connected to the foot of the cradle, is extended to effect the tipping movement. Power for the hydraulic rams is supplied by a pump directly driven by a 3 h.p. motor. Quick-release screw clamps can be provided on the cradle to hold drums or bins in position during tipping; sacks are held by a retractable steel claw.

The machines are made in various arrangements to suit particular classes of work and that illustrated is fitted with a hopper which receives the contents of sacks and provides a buffer stock between tipping operations. A valve at the bottom of this hopper controls a feed to one of the firm's portable sieving machines, which can be seen in its operative position in the hopper support frame.

[Reply Card No. E1453]

Electric Personnel Carrier

WE illustrate a battery-operated four-seater "Wrigley" electric industrial personnel carrier made by Wessex Industries (Poole), Ltd., West Street, Poole, Dorset. The carrier has been designed for use in works for conveying visitors, management, maintenance and breakdown staff, and similar transport requirements. It is powered by a C.A.V. traction motor driving through duplex chain reduction in a totally-enclosed steel plate housing mounted inboard of the nearside rear wheel. An Exide "Ironclad" 24V, 110 a.h. capacity traction battery is carried

Battery-driven vehicle for works transport. The carrier is 6ft 3in long and 3ft 9in wide overall

in a box under the front seat and is stated to give the vehicle a range of approximately 18 miles. Alternative capacities are available if required. Controls, located in a compartment in front of the driver, comprise a pedal-operated, five-step resistance controller and a forward-reverse switch. A Westinghouse VZ.12/10 charger with time control relay is provided.

The carrier weighs 850 lb, including battery, and will travel at up to approximately 15 m.p.h. loaded on a level surface. The turning circle is 16ft between kerbs or 17ft 3in between walls. Pedal-operated Girling 6in expanding brakes are fitted on the rear wheels, and there is a hand-brake lever for parking. The two bench seats are fabric-covered over foam rubber. Equipment includes two side and two rear lights.

[Reply Card No. E1454]

Fuel Feed Elevator for Stoker Hoppers

A SCREW elevator is now being made by James Hodgkinson (Salford), Ltd., Salford, Lancs, for the direct feeding of small solid fuels into the hoppers of chain grate or under-feed stokers from stockpiles at plants where it is not possible to install a ground hopper or pit. This elevator consists of a steel tube in which there is housed a rotating worm mounted on ball bearings and rotated by a totally enclosed motor at the top. Fuel raised by the worm is deposited into a short chute at the head of the elevator and is directed into the stoker hopper by a breeches piece which can be swivelled to suit the installation. At the tail end the elevator housing is slotted to allow the small coal in a stockpile to flow freely into the worm.

These elevators are made in standard lengths from 13ft to 18ft and are designed to handle up to $1\frac{1}{2}$ tons of smalls an hour. All that is required for their installation is a supporting sling for the upper end to position the delivery chute in respect to the stoker hopper; the tail end is then simply plunged into the stockpile.

[Reply Card No. E1455]

INDUSTRIAL NEWS

Capital Expenditure

Estimates of capital expenditure, based on forecasts collected from a sample of companies by the Board of Trade at the end of last year, indicate that private industry plans to spend this year 14 per cent more than in 1959 on fixed assets for use in manufacturing industry and 20 per cent more on assets for "other industries and services." The Board of Trade says that, taken together, capital expenditure by these two broad groups of industries is now expected to rise by 16 per cent this year, in contrast to the slight fall forecast after an inquiry made last summer.

The estimate that manufacturing industry's total fixed capital expenditure in 1960 will be about 14 per cent up on last year is made up of an increase of approximately 17 per cent in expenditure on plant, machinery and vehicles and an increase of about 8 per cent on building work. A substantial part of this increase is likely to be accounted for by the iron and steel and motor vehicle industries. If these two are excluded, the Board of Trade says, expenditure by the remainder of manufacturing industry is expected to be about 4 per cent higher this year than in 1959.

The latest estimates of capital expenditure by "other industries and services" indicate a total increase of 20 per cent. That figure is made up of an increase of 33½ per cent in expenditure on new building and an increase of 20 per cent in outlays on plant and machinery. Spending on new vehicles in this sector this year, it is thought, may not be appreciably higher than in 1959.

Outlook for British Exports

The January issue of *G.E.C. Export Guide*, prepared by the economic and marketing research unit of The General Electric Company, Ltd., shows the prospects for British exports to thirty-four major markets of thirty-six product groups. For the first three months of this year, it is stated, the outlook is good in twenty-one countries, improving in four countries, and unchanged (since last October) in nine countries. It is considered that, since last October, the outlook for British exports has improved in the Federation of Rhodesia and Nyasaland, India, Malaya and Singapore, Norway, Sweden and South Africa. There are no major markets where prospects have changed for the worse and only in Iraq and Venezuela does the outlook continue to be poor.

In addition to setting out these forecasts, the *G.E.C. Export Guide* includes a re-appraisal of Canadian trading opportunities. It comments that the Canadian economy has travelled from a state of uncertainty a year ago to a state of optimism and potential boom. But not all the indicators show strong recovery, investment, exports and construction activity being laggards. Inflation is being kept at bay in spite of increased earnings touching off high retail sales and consumer credit advances. Canadian exports, it is stated, were beginning to improve by the third quarter of 1959, mostly on account of increased sales of forest products. The United States share of Canadian exports rose from 58 to 62 per cent in the first nine months of 1959, compared with the same period of 1958. The United Kingdom's share dropped fractionally. The current Canadian prosperity has set up a strong demand for imports, which are growing faster than exports but, the *G.E.C. Export Guide* says, Mr. Diefenbaker's expectations of larger British exports to Canada have not materialised at the same rate as United States trade with Canada. Both indifferent British sales techniques and a trend towards closer Canadian-American relationships have been blamed for this situation. Yet the fact remains that Canada presents a most promising market for the British exporter if he can satisfy its particular demands.

Social Welfare in Industrial Communities

The fourth British national conference on social work is to be held at Bristol from April 10 to 13. The full title of this conference is "People and Work : Co-operation for Social Welfare in Industrial Communities," and it is expected that over 600 delegates will participate, representing industry and commerce, central and local government, trade unions, churches, universities and professional and voluntary organisations associated with social work. The three main topics to be studied are : the worker and the workplace in the neighbourhood ; health and the worker; and youth at work and at leisure. Other subjects to be discussed include such problems as the social effect of changing jobs ; the place of the older worker ; finding work for prisoners and ex-prisoners ; the employment and social life of coloured workers; and the impact on family life of shift working.

The conference secretary is Miss N. Rice-Jones, British National Conference on Social Work, 26, Bedford Square, London, W.C.1, from whom full details may be obtained.

F.B.I. and Price Reduction

This week, the president of the Federation of British Industries, Mr. W. H. McFadzean, has addressed a letter to the Chancellor of the Exchequer on the request to industry to reduce prices wherever possible or to prevent them from rising. The letter says that the F.B.I. has now given this request its careful study, and is, of course, aware of the benefits which the price stability of the past eighteen months has brought to the country. Every practical step, the F.B.I. agrees, should be taken to ensure that those benefits continue.

The F.B.I. thinks it should be fully recognised that all sections of industry—nationalised industries, private manufacturing industry, distributors and trade unions—have, together with the Government, a responsibility for price stability. The letter says that "the principle should be accepted by all concerned that the fruits of higher productivity can be shared when they are achieved and not before." It adds that all have a share of responsibility to see that costs are contained, that prices bear a reasonable relationship thereto, and that wage bargaining does not result in increased costs, whether by a rise in wage rates or a fall in standard hours of work, to an extent which would outpace national productivity and thus once again cause inflation.

Mr. McFadzean's letter goes on to point out that "part of the proceeds of the sales of products must be reserved for research and development of techniques and markets at home and abroad." Indeed, he says, unless some part of the margin between costs and selling prices is ploughed back in a company, improvement of its business and the growth of the country's prosperity will be retarded. There can be no question of freezing wages, prices or profits whether by statute or by voluntary agreement, the letter adds. Each company must determine its prices according to its assessment of its costs, of the challenge offered by its competitors at home and abroad, and of the long term interests of its own business and of the country as a whole, the general prosperity of which has such an important influence on the prosperity of any individual concern. The Federation believes that, given a general recognition of those facts, its members will wish to do everything in their power to help to maintain a generally stable level of prices.

Iron and Steel

Britain's steel production in December averaged 432,900 tons a week, which was 38 per cent higher than in December, 1958, and was, in fact, the highest rate achieved in any December. The increase in output prior to Christmas, the Iron and Steel Board says, continued the rise of 3 to 4 per cent a month begun in October. The total output of steel last year, which was a fifty-two week year, was 20,200,000 tons, compared with 19,600,000 tons in 1958 (a fifty-three week year). At present, production is running at about 23,500,000 tons a year and additional plant which is to be put into operation during 1960 will raise capacity to about 25,500,000 tons. The Board estimates that total steel output this year may reach 24,000,000 tons, though raw material supplies are expected to be available for a larger production if required. Pig iron output last year totalled 12,600,000 tons compared with 13,000,000 tons in 1958. But there were fewer furnaces in blast last year, the number being seventy-eight as against eighty-eight in 1958 and ninety-eight in 1957.

Finished steel deliveries in October and November last averaged 331,700 tons a week, compared with 270,900 tons a week in the corresponding period of 1958. Deliveries to the durable consumer goods industries, for example the motor-car, hollow-ware and metal furniture industries, all showed large increases, when compared with the two preceding years, and deliveries to general engineering were also higher. But deliveries to railways, coal mining and shipbuilding continued to decline. During the third quarter of last year, the United Kingdom's share of the international trade in steel products rose sharply to 16·1 per cent and was, in fact, higher than at any time since the beginning of 1957.

PERSONAL AND BUSINESS

Appointments

MRS. VIVIENNE D. JOHNSON has been appointed managing director of Detel Products, Ltd.

MR. A. NADIN has been appointed general manager of Brayshaw Furnaces, Ltd., and Brayshaw Tools, Ltd.

MR. P. D. TAYLOR and MR. F. B. CHAVENTRE have joined the sales division of de Havilland Propellers, Ltd.

MR. J. D. HOWDEN HUME has been appointed joint managing director of James Howden and Co., Ltd.

MR. F. J. COX has been appointed resident technical representative of D. Napier and Son, Ltd., in south-east Asia.

MR. R. P. HEATLEY has been appointed sales manager of Pye Process Heating with effect from February 1.

BELLISS AND MORCOM, Ltd., has announced the appointment of Mr. A. Cusins as manager of its London office as from February 1.

MR. G. C. DERBYSHIRE, A.M.I.Mech.E., has been appointed works and technical director of Jacobs Manufacturing Company, Ltd., and Frank Guylee and Son, Ltd.

THE FAFNIR BEARING COMPANY, Ltd., has announced that Mr. G. Marchant has been appointed general manager of its Wolverhampton and Hednesford factories.

MR. A. E. OSBORNE, London office manager for McCall and Co. (Sheffield), Ltd., has been appointed a director of the subsidiary company, McCalls Macalloy, Ltd.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., has appointed Sir Arthur Elton, Bt., to be controller of its central information department. He will take up his duties on March 1.

GUEST, KEEN AND NETTLEFOLDS, Ltd., has announced that Mr. Douglas Bruce-Gardner, Mr. Stephen Lloyd and Mr. Henry William Allen Waring have been appointed directors.

EASTERN REGION, BRITISH RAILWAYS, has announced the appointment of Mr. A. A. Harrison as assistant general manager in succession to Mr. S. G. Hearn who is retiring.

DR. C. J. STUBBLEFIELD, F.R.S., has been appointed director of the Geological Survey of Great Britain and Museum of Practical Geology. He will succeed Sir William Pugh, F.R.S., who retires on July 28.

MR. JOHN CARTER has been appointed technical representative of Sintered Products, Ltd., for the area covering Leicestershire, Derbyshire, Nottinghamshire, Yorkshire, Durham and Northumberland.

HUNTINGTON, HEBERLEIN AND CO., Ltd., has announced that Mr. A. T. Rogers, technical director and chief engineer, and Mr. R. F. Jennings, technical director, have been appointed directors of the company.

THE PRESSED STEEL COMPANY, Ltd., announces that Mr. John L. Lutyens, A.M.I.Mech.E., has joined its organisation as group director of research. He becomes a member of the motor-car body divisional board.

A.E.I. (RUGBY), Ltd., has announced the appointment of Mr. D. Edmundson, M.I.E.E., as general manager, Rugby Works. This will enable Mr. H. E. Cox to devote his time to the duties of deputy director of manufacture.

PERRY ENGINEERING, Ltd., announces that Mr. C. T. Bayliss has been re-appointed managing director in place of Mr. W. A. McLeod who resigned on December 31, 1959. Mr. Bayliss is also chairman of the company.

CABLE AND WIRELESS, Ltd., announces that Mr. R. H. Hensman has been appointed secretary in succession to Mr. F. H. Lansbury, who having passed the age of retirement will relinquish the position at the end of January.

BOWMAKER (PLANT), Ltd., announces that Mr. C. D. Wild has been appointed service manager at the Clay Cross branch, Willenhall. Mr. V. L. Mullowney, A.M.I.C.E., has been appointed area manager for South Wales.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY announces that Mr. H. Cartwright, at present serving as deputy director of industrial power in the authority's development and engineering group at Risley, has been appointed director of industrial power.

MR. E. W. BATHO, A.M.I.E.E., has been appointed London manager of Erskine, Heap and Co., Ltd., in succession to Mr. E. Jackson, A.M.I.E.E., who has retired after forty years' service in that position. Mr. Jackson remains a director.

MR. CHARLES EVANS and MR. PETER C. HAINES have joined the staff of the air traffic management division of General Precision Systems, Ltd., Fourth Floor, Bilton House, 54-58, Uxbridge Road, Ealing, W.5 (telephone, Ealing 1845-6).

THE COVENTRY VICTOR MOTOR COMPANY, Ltd., announces that it has engaged the services as engineering consultant of Mr. E. Chatterton, M.I.Mech.E., F.R.Ae.S., who, in collaboration with the chairman, Mr. W. A. Weaver, will assume responsibility for all engineering aspects of its business.

METROPOLITAN-CAMMELL CARRIAGE AND WAGON COMPANY, Ltd., announces that Mr. H. N. Edwards, having reached normal retiring age will relinquish his appointment as managing director on January 31, but will continue to hold the office of chairman. Mr. D. J. C. Robertson, M.I.Mech.E., A.M.I.E.E., general manager, will succeed Mr. Edwards as managing director.

MR. CHARLES W. HAYWARD, chairman of Firth Cleveland, Ltd., has been appointed to the board of the Solartron Electronic Group, Ltd., as from January 19, and has accepted the chairmanship at the invitation of the other directors. Mr. J. E. Bolton, formerly chairman of the group, will become deputy chairman. Mr. Gordon Harries, Secretary of Firth Cleveland, Ltd., is also joining the board of the Solartron Electronic Group, Ltd., with effect from the same date.

Business Announcements

MICHELIN TYRE COMPANY, Ltd., states that its Cardiff depot has moved to Garth Street, Adamsdown, Cardiff (telephone, Cardiff 33948/9).

NASH AND THOMPSON, Ltd., has acquired a second factory at Hook Rise, Tolworth, within 200 yards of its present research and production unit in Oakcroft Road, Chessington, Surrey.

THE UNITED STEEL COMPANIES, Ltd., states that on and after January 25, the address of the head office will be (G.P.O. Box 64), The Mount, Broomnill, Sheffield, 10 (telephone, Sheffield 60081).

INDUSTRIAL PUMPS, Ltd., 20, Bentinck Road, Hyson Green, Nottingham, has opened a new branch office and depot at 62A, Station Road, Kings Langley, Hertfordshire (telephone Kings Langley 4465).

R. H. COLE (OVERSEAS), Ltd., 2, Caxton Street, Westminster, London, S.W.1, announces that it has been appointed sole United Kingdom importer and distributor for the communications test gear made by Siemens and Halske.

PHOTOELECTRONICS (M.O.M.), Ltd., Oldfields Trading Estate, Oldfields Road, Sutton, Surrey, announces that Paton Brothers Engineering Services has been appointed as representative for its products in Yorkshire, Lancashire and Cheshire.

THOMAS MERCER, Ltd., Eywood Road, St. Albans, has been appointed sole industrial distributor in the United Kingdom for the honing machines manufactured by the Sunnen Products Company of 7910, Manchester Avenue, St. Louis 17, Missouri, U.S.A.

W. J. BROOKER, Ltd., 28, Westminster Bridge Road, London, S.E.1, has announced the formation of an associated company Brook-Blast, Ltd., which will specialise in on-site shot blasting, metal spraying and protective coating operations. The directors are Mr. W. J. Brooker and Mr. D. M. Leggett.

WELDALL AND ASSEMBLY, Ltd., Old Wharf Road, Stourbridge, Worcestershire, has been granted licensing arrangements by Fried Steel Equipment Manufacturing Corporation of New York, for the manufacture and sale of Fried units on a world-wide basis with the exception of the Americas and Canada.

DAVID BROWN TRACTOR DIVISION, Huddersfield, and the OLIVER CORPORATION, Chicago, have signed a purchasing agreement whereby the American company will buy tractors of David Brown manufacture and market them in the U.S.A., Canada and South America as an addition to its own range of tractors.

ROTO-FINISH, Ltd., Mark Road, Hemel Hempstead, Herts, has acquired a substantial interest in N.V. Roto-Finish Maatschappij Rotterdamseweg 370A, Delft, Holland. An agreement has also been reached whereby the sales programmes and the service organisations of the two companies will be integrated.

SHELL INTERNATIONAL PETROLEUM COMPANY, Ltd., announces that the interests of the Royal/Dutch Shell group of companies, Continental Oil Company and the Union Stockyards and Transit Company of Chicago, in the liquefied natural gas field are to be developed through a jointly-owned company to be known as Conch International Methane, Ltd.

LANDIS MACHINE-MAIDEN, Ltd., Hyde, Cheshire, states that Alfred Herbert, Ltd., has been appointed sole selling agent in the United Kingdom for machinery of its manufacture which is fitted with Landis tangential threading equipment. This does not, however, include the range type "A" and "ST" radial diehead machines, together with the bar chamfering and tagging machines.

BRIGHTON TECHNICAL COLLEGE has established a National Centre of Information on automatic programming of digital computers. The purpose of the Centre is to establish and maintain a comprehensive library of publications, papers, research reports and other material, relevant to the problems of automatic programming; to publish an "Annual Review in Automatic Programming" to provide a "clearing house" for information and inquiries on automatic programming, and to help co-ordinate the work of other bodies active in this field; to organise small working conferences and to maintain contact with organisations in other countries concerned with such matters.

THE HUNTING GROUP OF COMPANIES announces that in order to simplify and streamline the structure of certain British and Canadian companies the following changes have been made. In Britain, the activities of Hunting Geophysics, Ltd., have been merged with those of Hunting Aerosurveys, Ltd., and the name of the new combined company is Hunting Surveys, Ltd. In Canada, the activities of The Photographic Survey Corporation, Ltd., Hunting Airborne Geophysics, Ltd., and Hunting Technical and Exploration Services, Ltd., have been combined under the name of Hunting Survey Corporation, Ltd. Mr. T. D. Weatherhead, former managing director of Hunting Aerosurveys, Ltd., is managing director of Hunting Surveys, Ltd., and Mr. D. N. Kendall, vice-president of Hunting Associates, Ltd., the controlling company for all Hunting's aviation and survey interests in Canada, is president of Hunting Survey Corporation, Ltd. Mr. C. P. M. Hunting remains president of Hunting Associates, Ltd., and is chairman of Hunting Surveys, Ltd.

Contracts

THE ENGLISH ELECTRIC COMPANY, Ltd., is to build at its Netherton works six hydro-electric generators for the Saskatchewan Power Corporation's Squaw Rapids scheme on the Saskatchewan River. They will be vertical shaft umbrella type machines, each with a nominal rating of 37·5MVA, 0·9 p.f., 14·4kV, 60 c/s at a speed of 120 r.p.m. The first set is to be commissioned in late 1962 and the whole development is to be completed by 1964.

HUMPHREYS AND GLASGOW, Ltd., in association with Japanese licensees, has received an order to install an Onia-Gegi process oil gasification plant in Osaka, which, it is stated, will eventually be the largest of its kind in the world. By the end of this year, four units each making 5,000,000 cubic feet of town gas a day will be in operation, and the total cost of this installation will be about £700,000. Eventually further units will be added to bring the total capacity of the plant to 30,000,000 cubic feet a day.

A.E.I., Ltd., Heavy Plant Division, Rugby, has received from Australian Electrical Industries Pty., Ltd., orders worth nearly £700,000 for electrical equipment for Australian rolling mills. The main order is for drives for a new five-stand tandem cold strip mill to roll wide strip at a maximum speed of 5000ft a minute. D.C. motors with a total output of 20,750 h.p. will drive the mill and its tension reel, and the generators feeding them will be driven by two 10,000 h.p., 750 r.p.m. synchronous motors. Stand 1 will be driven by a single-unit 2000 h.p. motor; Stands 2, 3 and 4 each by a double-unit 4000 h.p. motor; Stand 5 by a triple-unit 5500 h.p. motor; and the tension reel by a triple-unit 1250 h.p. motor. Most of the control equipment will be made in Australia to suit the control scheme designed by Heavy Plant Division engineers, but "Magnestats" (magnetic amplifiers) supervisory control panel, high-speed circuit-breakers, and rheostats will be supplied from Great Britain.

CONTINENTAL AFFAIRS

by Our Continental Editor

Construction of Tjörn Bridge

An unusual bridge design is being employed for the main crossing of the Askerö Fjord, in the course of constructing a road from the mainland to the island of Tjörn off the Swedish west coast. It is an arch bridge comprising twin 3·8m diameter tubular steel girders of 278m span and 40·5m rise, fixed at the abutments. The tubular girders were decided on because of their lower wind resistance in an exposed situation as well as lesser manufacturing and transport costs as compared with an equivalent rectangular section. The erection of the steelwork, now nearing completion, is being carried out with the help of temporary cable suspension carried over towers. The bridge is to come into service this summer.

BECAUSE of its varied coastline and the multiplicity of its fjords and islands, the west coast of Sweden has proved very attractive to tourists, so that every summer many families spend their holidays there. In order to further tourist travel and at the same time meet the needs of the local population it was decided some years ago to complete the already existing connection between the principal off-shore islands, Orust and Tjörn, by a road connection to the mainland over the Askerö Fjord near the town of Stenungsund. The most convenient way of achieving the crossing was by using the small islands of Stenungsön, Källön, and Almön as stepping stones. Tenders were invited in April, 1956, by the Swedish Department of Public Works (Kungl. Väg-och Vattenbyggnadsstyrelsen) and eventually the contract was awarded to the Swedish firm AB Skånska Cementgjuteriet as main contractor. Plans included the construction of two multi-span prestressed concrete bridges from the mainland to Stenungsön and from there to Källön, a short tunnel through the ridge of the former island, and a dam between Almön and Tjörn. The main crossing over the Askerö Fjord was to be a steel arch bridge to a design submitted by M.A.N., to be carried out by a Demag–M.A.N. working group as sub-contractor, while the concrete approaches and abutments were the responsibility of Skånska.

The twin arch girders are tubular with a constant outside diameter of 3·8m ; they span a distance of 278m and rise 40·5m above the supports to which they are fixed with a heavy prestress. With a height of the arch abutments of 3·84m above mean sea level, a clearance of not less than 41m is obtained over a 50m-width in the centre. This is necessary in order to allow shipping to pass freely in and out of the important seaport of Uddevalla at the head of the fjord. In the accompanying illustrations (Figs. 1 and 3) the bridge is shown at different stages of erection ; the procedure will be described later on in this article.

Several considerations influenced the choice of design. The first point is the smaller aerodynamic drag of a circular section compared with an equivalent rectangle. Winds in the notoriously stormy Skagerak reach velocities of 140km per hour, so that wind resistance was a principal factor. To cater for this aspect was made more difficult by the tall and slender construction required : the bridge had to be tall so as not to impede shipping, and slender, as for reasons of economy the total width of the roadway (except for a slight widening near one of the abutments) was to be only 9·4m. On the other hand lightness was at a premium, not only because of the cost of manufacture, but also because all parts had to be shipped from the contractor's works at Gustavsburg near Mainz. Since lack of suitable level space near the site made it necessary to carry out all local assembly on the 80m by 15m deck of a pontoon, the bridge had to be despatched in large prefabricated sections which yet had to be capable of being handled and assembled without fear of damage.

Safety being the main consideration, wind tunnel tests were carried out at the Technical University of Stuttgart where a working section of 32 square metres is available. The two 2000kW fans of the tunnel provided a wind velocity of 270km per hour for the tests which were done with single and twin tubes of 1·2m diameter and varying degrees of surface roughness. The latter is a crucial point as increased roughness due to coats of paint and snow and ice considerably enhances the air resistance of the real bridge.

An extensive series of tests was also carried out to determine the buckling strength of the girders, since no previous work was available on steel test objects of comparable size, under combined bending and compression. The results of these tests showed a cylinder of 3·8m diameter and 14mm wall thickness, without any longitudinal ribs, to be more resistant to local buckling than an equivalent rectangular box girder incorporating a large number of such ribs.

Approaches

Before discussing the steelwork in detail, a word must be said on the subject of the elevated approaches, which were constructed first. From the hillside, the bridge is reached at each end over elevated roadways of prestressed concrete, supported by slender concrete columns spaced in pairs 8·7m apart. The two end columns on either side, which also form the abutments for the bridge deck, are heavier in section than the rest and stand on the same concrete footings as the steel arches. These columns are 2·5m in diameter, and are joined at the top by a concrete beam; the roadway at the supports is about 42m above mean sea level. While the approach from the direction of Stenungsund and Källön is only slightly curved at a little distance from the bridge, the Almön side curves away sharply with a radius of 150m. Both the super-elevated curve and the transition from super-elevation to level at the end of the bridge deck are about 0·70m wider than the rest of the roadway which comprises a 7·5m carriageway, with a 1 in 40 camber on either side from the centre, and 0·75m-wide footpaths on each side protected by tall 0·2m-thick kerbs, making the total width of the deck 9·4m exclusive of railings.

The tubular arches are each built up from thirty-seven cylindrical sections. These differ somewhat in length but, apart from the shorter centre section, they are all about 8·5m long. The wall thickness increases from 14mm near the crown to 22mm at the abutments. The end sections and every third section of each girder, as well as the centre portions, are interconnected by plate cross-girders. The intervening spaces are filled with triangular lattice bracing in the line of centres of the two cross sections. Where the cross-girders are attached, each tube has transverse internal ribs as well as an internal tubular strut, diametrally placed in the plane of the cross-girder (Fig. 2). Similar internal

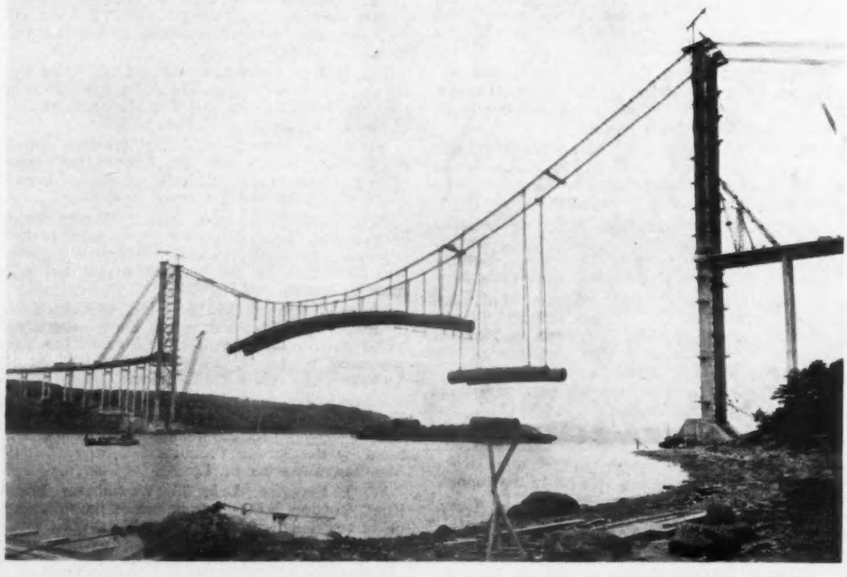
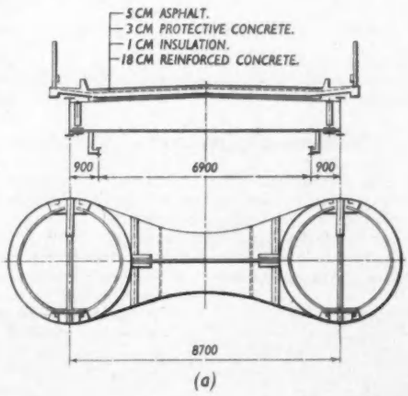
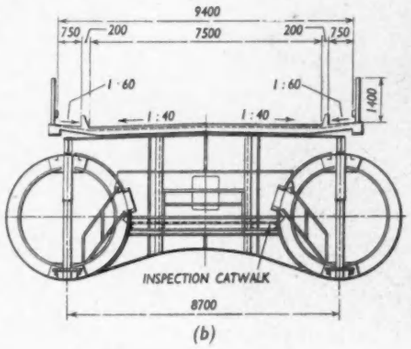


Fig. 1—Bridge over the Askero Fjord for connecting the island of Tjörn with the mainland. The bridge, here shown during erection, spans the fjord between the small islands of Källön (right) and Almön (left). Note the tubular tandem arches, hoisted into position from a pontoon with the help of a temporary suspension



(a)



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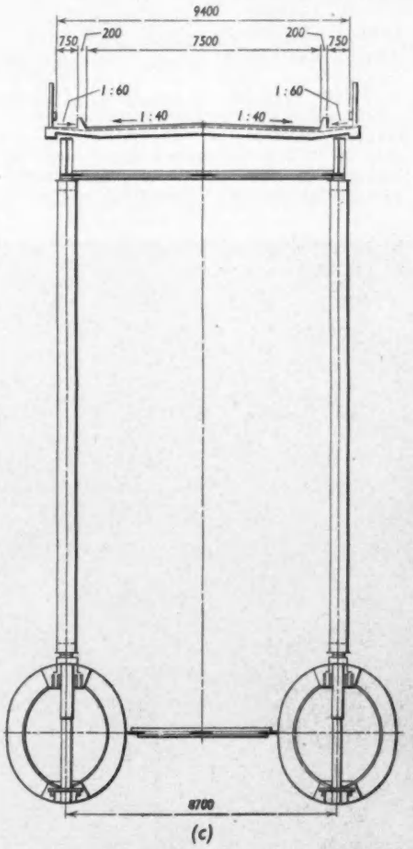


(c)

(a) Section at one of the cross-girders.
(b) Section at centre of span.
(c) Cross section through a pair of supporting columns.

Fig. 2—Details of the bridge

Fig. 3—The bridge during a later stage of construction. The arches are connected to the abutments and the deck and its supporting columns are being placed in position. The arch spans 278m, rises 40·5m, giving about 41m clearance under the central portion of the bridge

stiffening ribs and struts, though without the external cross-girder, are provided at the points where the vertical columns are attached which support the road deck. There are twelve of these columns on each girder, with diameters from 0·30m to 0·70m. They bear on the structure above and below by means of spherical bearing caps.

The arches end in flat circular plates which are pressed against the concrete with a prestress of about 5000 tonnes at each support (Fig. 4). The principal dimensions of the bridge are shown in Table I.

The main girders can be inspected internally and externally using suitable catwalks, while inspection carriages are being fitted to inspect the underside of the deck on each side to within 29m of the middle, the central part, where headroom for a carriage is lacking, being provided with an inspection gangway.

The deck steel structure is in three sections. The main sections extend on either side between the abutments and a point 22·68m from the centre ; at these points the outer deck sections are attached to one of the arches, while the middle section is similarly attached at the centre. The corresponding points on the other arch are movably supported while the outer ends rest on roller bearings, permitting only lengthwise movement. These arrangements are so as to permit the deck to accommodate itself without strain to lateral deflections of the arches under

TABLE I—*Principal Data of Tjörn Bridge (Askerö Fjord)*

Span of arch, metres	278·04
Rise of arch, metres	40·52
Height of abutments above datum (mean sea level), metres	+3·84
Length of steelwork, metres	288·36
Height deck at abutments, above datum, metres	+42·13
Height deck at centre, above datum, metres	+47·10
Clearance over 25m either side of centre, metres	≥41
Centre distance of arches, metres	8·7
Diameter of tube girders, metres	3·8
Spacing of steel columns, metres	16
Diameter of steel columns, metres	0·3 to 0·7

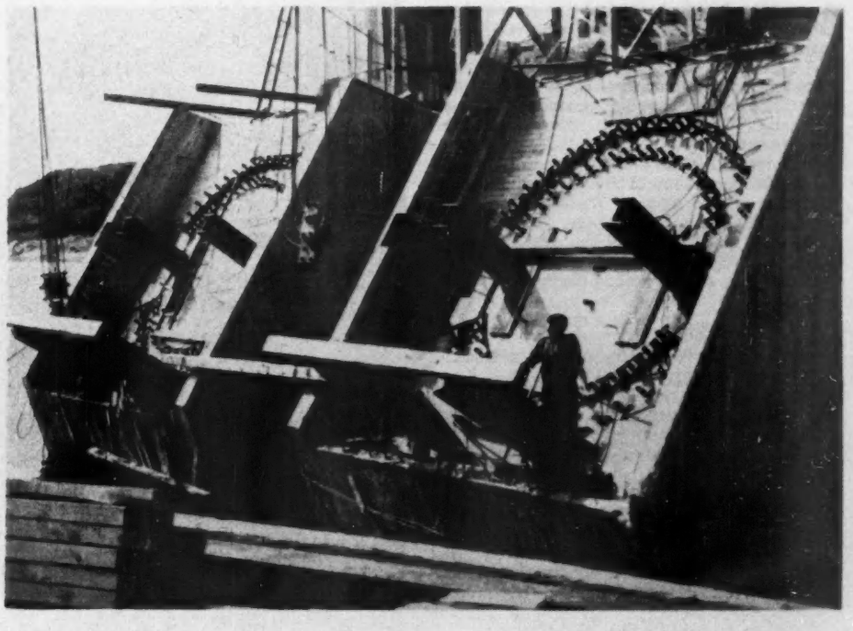


Fig. 4—Two of the arch abutments, each with 152 prestressing bolts let into the concrete; each support exerts about 5000 tons in order to prevent lifting of the arch

CONTINENTAL AFFAIRS *(Continued)*

wind loading which at the crown may attain up to 155mm.

The deck comprises a number of independent 32m-long, sections. Each is of compound construction of steel and reinforced concrete 18cm thick. On the concrete are placed a 1cm-thick insulating layer, topped by 3cm of concrete and 5cm of asphalt. The connection between the steel framework and the concrete is made by means of stirrups welded to the top flanges of the cross-girders.

Erection

Various possible erection methods were investigated, using a 12m-long, 1 : 50 full scale model. A cantilever construction would have been difficult because the strong tides and a water depth of 30m would have made the placing of auxiliary supports an extremely costly business. In addition it was not permissible to obstruct shipping or to close the fjord for any length of time.

Inclined supporting cables were considered, but again the large unsupported cantilever span and the danger from strong winds were counter indications. Since cable-cranes of the required capacity, about 30 tons, have not yet become available for spans like the present of about 300m, their use also had to be left out of consideration.

With a light construction like the present, it was also important to devise a method of erection which would not require the use of surplus material in order to provide temporary stiffening.

Another difficulty, already referred to, was caused by the absence of any level ground in the neighbourhood on which assembly work could be carried out.

It was therefore decided to erect two 50m-high towers on the previously completed concrete abutments and to carry over these a suspension of two by twenty-four cables somewhat like that of a suspension bridge. On this suspension the arches were hoisted into position in the manner of the deck of a suspension bridge. A start was made at the centre, and alternate twin sections were raised and put into position at each end in turn until the supports were reached. Altogether, eleven such sections were assembled on the pontoon from sub-sections arriving by sea and erected in this way. These sections were up to 40m long and weighed 120 to 160 tons. Connections were made by riveting and high-tensile bolts.

A high degree of accuracy had to be achieved since any straining due to errors of shape would have called considerable secondary stresses into play. Before being shipped the arches were pre-assembled at Gustavsburg in a horizontal position. The correct shape of the arch during erection was checked by fastening measuring staffs to the sides of the arches on which sights could be taken, as may be seen from Figs. 1 and 3. Erection of the steelwork began earlier last year and is now nearing completion. The bridge is due to be commissioned in June.

Large Tipper Truck

We have received details of a large capacity tipper truck made by Bennes Marrel, Rue Pierre Copel, Saint-Etienne. The truck, shown in the accompanying illustration, comprises a Berliet "T.100" chassis surmounted by a hopper body. The latter has a geometrical capacity of 23 cubic metres but can carry up to 35 cubic metres heaped up. Made of steel plate, including manganese steel, it has a 10mm-thick floor plate strengthened on the underside by 100mm-thick oak planking and a second 5mm steel plate, as a protection when loading large rocks or heavy ore. The sides and floor are reinforced by heavy box sections. The tipping angle is 65 deg., the scow end angle, 25 deg.

The tipping mechanism consists of a single four-sleeve telescopic ram with a largest diameter of 280mm and a stroke of 1·55m, having a capacity of 120 tons. A 3000 lb per square inch, 150 litre per minute piston pump allows the ram to be completely extended in fifteen seconds. The pump delivery is controlled by a valve which also permits a quick return of the oil for lowering the hopper. Two hydraulic brakes are fitted to avoid self-tipping when the centre of gravity of the load passes beyond the scow hinge during dumping. The scow end is supported during unloading on two hydraulic jacks which are controlled from the cab.

A load of up to 35 cubic metres can be carried on this tipper truck and dumped in fifteen seconds. The wheels have a diameter of 2·28m

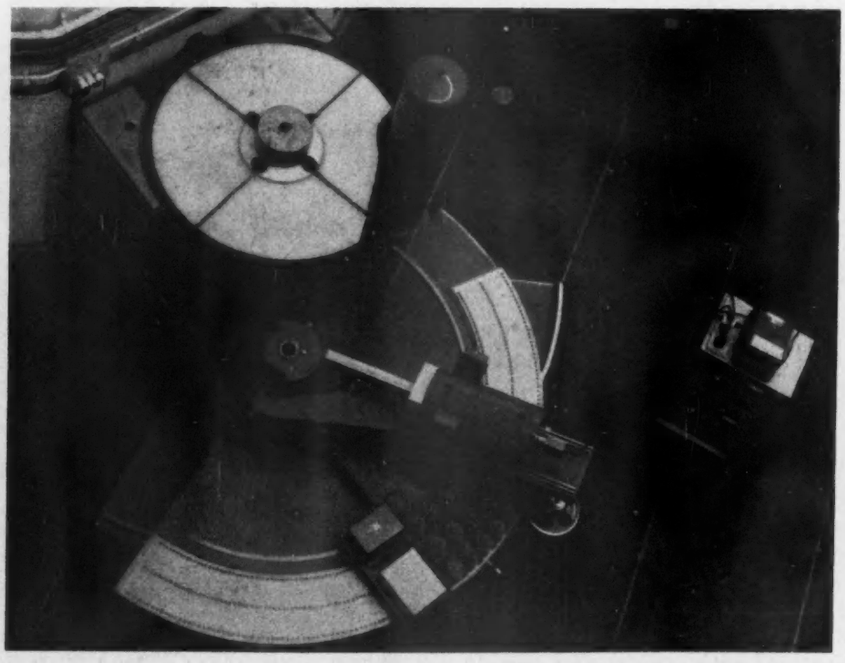
Fitted with 2·28m diameter wheels with disc brakes, the chassis is powered by a 600 h.p. Cummins engine driving through an eight-speed gearbox (see Plate 13, January 10, 1958). Gross weight of the equipment is 125 tons, including a payload of 65 tons.

Neutron Diffraction Apparatus

In the nuclear research reactor "Garching," near Munich, the Institute of Technical Physics of the Technological University of Munich has taken into operation a neutron diffraction apparatus which is stated to be the first of its kind. The equipment is of standard design and can be modified to suit any type of reactor and special requirements.

The neutron diffraction apparatus serves for examining the structure and structure-sensitive properties of solid materials, the principle employed being similar to that of X-ray diffraction. Certain problems of the physics of solid materials, such as the examination of the magnetic structure or the analysis of the thermal vibration spectrum, can, however, be clarified only by employing neutron diffraction. Such experiments demand high neutron intensities, i.e. they require a nuclear reactor.

The apparatus, shown in our illustration, was built in conjunction with M.A.N., Augsburg. It embodies a special drive permitting the neutrons scattered on the test specimen to be scanned automatically by steps as low as five minutes of arc. In this way the counter covers an angular range of 130 deg. during a chosen period which may be extended to up to one month. Neutrons of uniform energy are obtained by reflection from a crystal located in the centre axis of the movable shielding, which protects the operating personnel and weighs 2·5 tons.



This diffraction equipment produces a "monochrome" beam of neutrons from the beam emerging from the reactor, by reflection from a crystal placed inside the heavy cylindrical shield. The scattered beam from the test specimen at the centre of the quadrant is analysed by means of a counter indexed in small steps through an angle of 130 deg.

Swedish Mine Hoists for U.S.S.R.

LAST month, the Swedish A.S.E.A. concern (Allmänna Svenska Elektriska Aktiebolaget Västerås) delivered two mine winders to the U.S.S.R. as part of a major order. The equipment, shown in our accompanying illustrations, is stated to be the largest of its kind in the world.

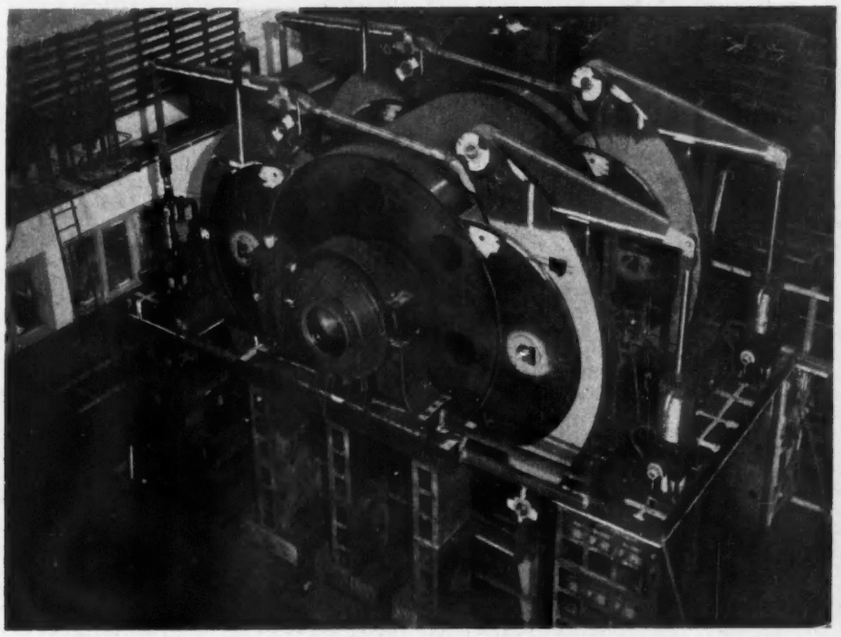


Fig. 1—Friction pulley of eight-rope mine hoist, during assembly at the maker's works. The weight of the 4m diameter pulley is 49 tons

Each winder is designed for double skip hoisting. The individual skips weigh about 40 tons, and the net load will be 50 tons per skip. Initially, the depth of the shaft will be 900m and the hoisting speed, 10m per second. Later, the shaft will be deepened to 1300m and the speed increased to 14m per second. For purposes of comparison it may be mentioned that the winders at the Kiruna iron ore mines in Northern Sweden have a net load capacity of 20 tons. It is stated that until now the maximum load hoisted at such high speeds has been 25 tons.

The drive is by means of a friction-drive pulley weighing 49 tons (Fig. 1). In spite of the heavy load, the pulley diameter is only 4m ; this is because the load is distributed over eight ropes, while previously the maximum number of ropes employed with this type of drive was four.

The total motor rating is 9000 h.p., and the power is provided by four motors which are connected to the pulley by means of two double-reduction gearboxes, one on each side (Fig. 2). Each gearbox is driven by two A.S.E.A. d.c. motors standing side by side. When at a later stage the hoist speed is increased to 14m per second the rating will have to be stepped up to 12,000 h.p.

Two converter sets are provided for the Ward-Leonard drive, each comprising a 6kV, 600 r.p.m. synchronous motor coupled to two d.c. generators.

In addition to the winding equipment, A.S.E.A. is also supplying ropes, skips, measuring hoppers, and underground conveyors for transporting the ore from the crushers to the measuring hoppers. The contents of the latter are to be weighed with the aid of pressure transductors which stop the filling operation as soon as 50 tons of ore have been fed into the hopper. As soon as a skip stops in the filling position it is filled from the hopper which subsequently closes again for refilling while the skip is hoisted to the surface. The whole cycle of operations is automatic.

Besides the two 50-ton winders described, A.S.E.A. is supplying the U.S.S.R. with a six-rope friction-drive winder and six four-rope winders.

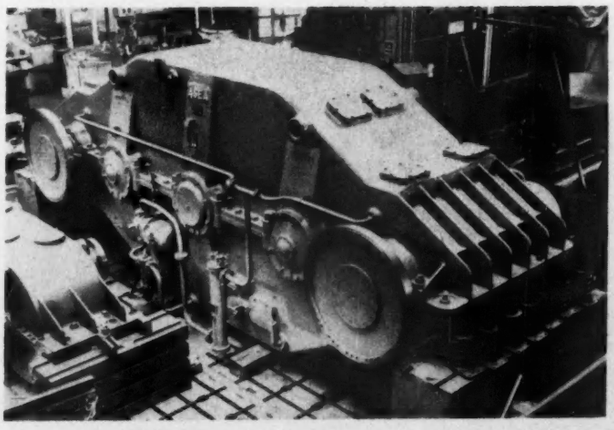
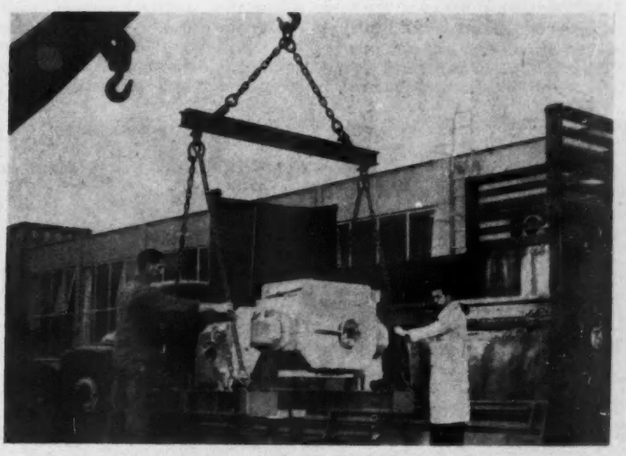


Fig. 2—Double gearbox for mine hoist. Two such gearboxes are being installed, one on each side of the friction pulley. Initially, four motors with a total rating of 9000 h.p. will give a hoist speed of 10m per second from a depth of 900m

Mobile Industrial Betatron

A mobile betatron has been developed by Siemens-Reiniger-Werke A.G., Erlangen, from the same firm's clinical betatron, for use in the testing of large steel thicknesses such as heavy welds. The dimensions and weight of the equipment were kept down so that both the power and control unit, and the radiation head, can easily find room on small trolleys on which they can be transported to the working site. For long distance transportation the whole installation can be carried on a heavy lorry. The radiation head can readily be adjusted to point in any direction required. Protection from stray radiation is incorporated so that few additional safeguards are necessary. As is well known, in the betatron electrons are accelerated to nearly the speed of light inside a circular vacuum chamber subjected to an alternating magnetic field. In one two-hundredth of a second, the electrons revolve over 200 million times round the chamber, and in doing so traverse a distance of about 1500km. They then hit an anti-cathode, as in an ordinary X-ray tube. Because of the very high energy of the electrons, amounting to 15,000,000 electron-volt, extremely hard and penetrating X-rays are obtained. In this way the radiographic exposure time for steel thicknesses of 150mm to 200mm is of the order of a few minutes, while a thickness of 400mm requires one to two hours. With a standard X-ray tube, several days' exposure would be required in the latter case. The total weight of the installation is 3·5 tonnes.

An important application of the betatron is in the manufacture of heavy-walled vessels for reactors, steam boilers and chemical processes. The instrument shown in the accompanying illustration is the first of its kind to be supplied by Siemens and is to be jointly owned and operated by a foreign group of companies.



Radiation head of industrial betatron mounted on a trolley for transport purposes. The whole unit weighs 3·5 tonnes and can be transported on a lorry

THE AMERICAN SCENE

by Our American Editor

Industrial Processing Applications of Electron-Beam Radiation

No. III—(*Concluded from page* 116, *January* 15)

Penetrating high-voltage electron-beam radiation has, within the past few years, drawn widespread industrial attention as a promising processing tool, and many American companies and institutions are now engaged in intensive programmes of research and application. The efforts of these groups extend from fundamental studies on the basic interaction of radiation with matter to the actual operation of radiation processing facilities. While many kinds of radiation sources have been proposed and investigated over the past few years, the Van de Graaff and microwave linear particle accelerators are now generally recognised as the principal sources of radiation for industrial use.

Linear Accelerator

THE Corporation's series of microwave linear accelerators for processing are intended for applications where deepest penetration is a basic requirement. Four "linacs" are available at present, and all are physically identical except for the acceleration tube that establishes the performance rating. The acceleration tubes are interchangeable; hence, any of these machines can be given different output characteristics by changing the acceleration tube.

The microwave acceleration section of the machine is of modular design and includes a precision microwave guide. Mounted on the tube is an electron injector, which consists of a cathode and electron gun that injects electrons at a predetermined energy. This section also includes: (1) an r.f. power amplifier valve, complete with driver-oscillator system and power supplies; and (2) an oil-fractionating high-vacuum pumping system capable of evacuating the electron injector as well as the acceleration tube.

The control modulator section contains the power supply and modulator of the r.f. system with controls for beam current, pulse repetition rate, frequency, r.f. power, acceleration-tube focus current and beam-scan width. The beam scanner provides for an adjustable scan from 5in to 15in. It includes an electron window and power supplies.

The accompanying diagram shows the principal dimensions of the machine arranged for electron-beam processing. An installation of a 7 MeV linear accelerator at the Somerville works of Ethicon, Incorporated, in New Jersey, is shown in another illustration, Fig. 17. This firm is believed to be the world's largest producer of surgical sutures and changed from heat to electron-beam sterilisation of its products. This change has resulted in a stronger product, a better package, simpler manufacture and continuous processing.

Surgical sutures are of two main kinds: absorbable and non-absorbable. The absorbable variety, known as "catgut," is derived from connective-tissue layers of the intestines of beef and sheep. It is with this kind of material that the suture industry has always had sterilisation problems. As early as 1949 it was well established that electron-beam irradiation is capable of killing micro-organisms at doses that do not adversely affect many materials. Subsequent work established the dose parameters necessary to sterilise sutures and similar objects. However, the large capital investment required and the lack of definitive experience with the commercial use of electron accelerators, beta and gamma radiation deterred most industries from extensive development work. Early in 1953 the problems peculiar to the suture industry prompted Ethicon to undertake a detailed feasibility study of radiation sterilisation of sutures. The firm rented a 2 MeV, 0·5kW Van de Graaff accelerator and embarked on an extensive research project. This established the minimum killing dose for over 150 different species of micro-organisms and found the maximum dose that could be safely tolerated by catgut. A value of 2·5 megarads was chosen as the sterilising dose. This is 40 per cent above the minimum to kill the most resistant micro-organism. Catgut can tolerate 5·0 megarads before becoming inferior to heat-sterilised gut.

The firm decided to install both a 2 MeV Van de Graaff and a 7 MeV "linac" machine, to house them in the same area and place them close to its older sterilisation facilities. This provides a logical flow of materials through the manufacturing operation and permits the greatest flexibility for any later mechanisation. The accelerator building is separate from the main manufacturing building but connected to it by an enclosed passageway. This permits an eventual expansion of the manufacturing area in the direction of irradiation facilities and at the same time maintains the normal process flow. The lowest level of the accelerator building is partly underground and comprises two irradiation rooms each surrounded by 7ft of concrete. This thickness was based on calculations of probably hard X-rays generated by electrons striking the metal conveyor belt and other objects. Half a storey higher and in front of the target room is the production area for loading and unloading conveyor belts. The firm only recently extended the conveyor system to lead into the manufacturing area. The operating controls and monitoring devices are also on this floor. About 3ft higher, above the target rooms, are the accelerator rooms. The highest level is half a storey above the production area. This is a mezzanine that houses the high-frequency amplifiers and the power supply for the "linac." Maintenance workshop and testing instruments are also on this floor. Access to both accelerator rooms and target rooms is through a passage with two right-angle turns. These turns effectively block all stray radiation.

The whole installation is designed to obtain maximum safety. The shielding is adequate for nearly complete absorption of all radiation. The doors leading to the target and accelerator rooms are locked and interlocked with the machine. Opening of any of these doors will turn off the machine instantaneously. When the machine is turned on, there is a delay in starting up. During this delay a horn sounds repeatedly to warn people that irradiation is about to begin. Through a maze-and-mirror system, the target room can be easily inspected.

It is of interest to note that the new surgical suture package of Ethicon, which comprises

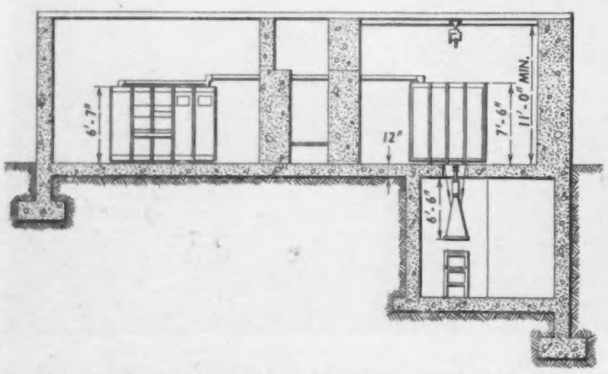


Fig. 16—Sectional elevation of microwave linear accelerator installation for electron-beam processing

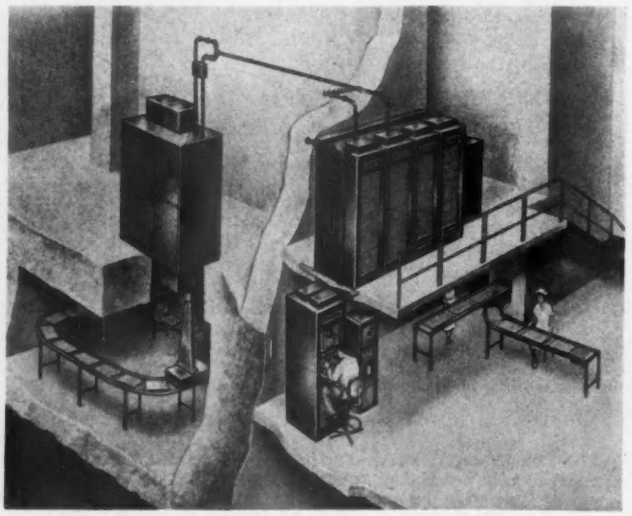


Fig. 17—7 MeV microwave linear accelerator with beam scanner installed at Ethicon Incorporated

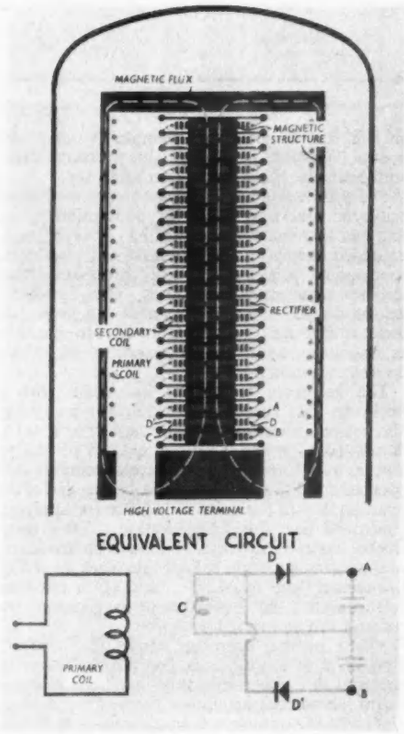


Fig. 18—Diagram of the insulating core transformer, without electron acceleration system

aluminium foil, vinyl plastic and paper and was made possible by the introduction of electron-beam sterilisation, was recently awarded the 1959 Corporate Award for outstanding achievement in applied packaging, by the American Packaging Institute.

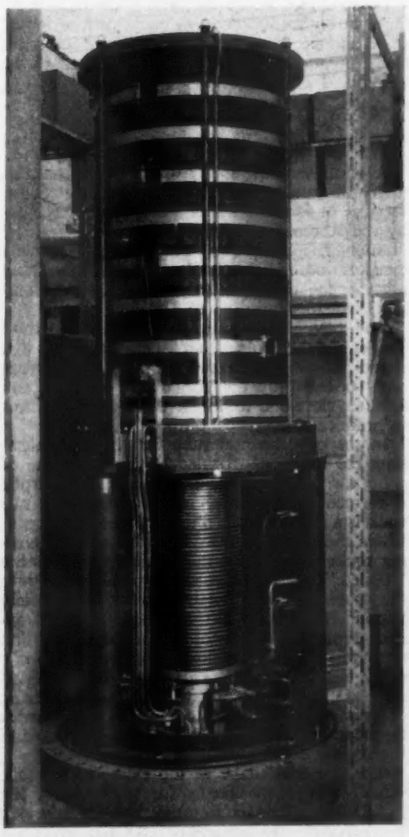


Fig. 19—1 MeV insulating core transformer accelerator, with the tank removed

New Radiation Sources

At present, three new designs of accelerators are being developed by the High Voltage Engineering Corporation. They are all "direct" accelerators in which the generated voltage is applied through divider-resistors to an acceleration-tube system. However, each embodies a different principle of voltage generation; two are electromagnetic accelerators and the third accelerator is electrostatic. All would be practical for energies up to about 4 MeV, and are designed for beam currents greater than 15mA.

(1) *The Insulating Core Transformer.*—In a conventional voltage transformer the primary and secondary coils are linked by an iron core. While intense magnetic fluxes are developed, the device is limited in voltage "step-up" to several hundred kilovolts, unless several transformers are cascaded in series. The limitation is due to the large amount of insulation required between the secondary windings which carry peak voltage and the core, which is essentially all at ground potential. Thus, the conventional transformer has never been useful to the super-voltage field of application. In the voltage-generating column of the insulating-core transformer, a portion of the magnetic core is divided into segments which are insulated from one another. Thus, each core segment can exist at the total voltage potential developed at that stage. No insulation is required from windings to core, and very little is needed between core segments. At the high-voltage terminal there is a large insulating gap to the remainder of the core. The magnetic reluctance of the circuit is kept low by maintaining very short gaps between core segments and by providing a large surface area for the long gap at the terminal. Thin plastics materials of high dielectric strength are used in the small gaps. The voltage insulation in the terminal gap depends on pressurised gas, which surrounds the entire transformer.

The illustration (Fig. 18) is a schematic diagram of this transformer, with the acceleration system shown. The high-voltage terminal is at the bottom of the central column in this diagram. The top of the column and the outer shell of core material form the outer path of the magnetic circuit and are at ground potential. Power is delivered to the primary coil by a motor-generator or a signal generator at a frequency above 1000 c/s. Each core segment is a pancake and is surrounded by a ribbon winding, which is the secondary of the transformer circuit. A voltage of about 25kV is induced in each secondary winding. The a.c. power developed in the secondary windings is converted to d.c. power by means of dry rectifiers. Each core segment with its associated windings and rectifiers forms a compact d.c. power supply. In the first model, each assembly has been tested in continuous use at 25kV and 30mA, or 0·75kW of power. Voltage addition is obtained along the column by the distributed series capacitance between the core segments. The voltage ripple of the transformer is less than 3 per cent and the overall efficiency of power conversion is about 90 per cent.

The photograph (Fig. 19) shows a 1 MeV accelerator with the tank removed. The acceleration tube is mounted below the transformer, as an extension of the latter on the same vertical axis. The outer magnetic shell above surrounds the primary coil and the stack of insulating cores. The first model has been designed for a beam current of 40mA at 1 MeV. The extension of this intensity in future models depends on the choice of rectifiers rather than on the magnetic circuit, and some rectifiers are now available which should allow a load of 1A. As an electron accelerator, this design has a potential for delivering a megawatt of power in a multi-tube acceleration system.

(2) *The Transmission-Line Accelerator.*—The basic principles involved in the development of this accelerator can be illustrated by referring to a long transmission line suspended above ground at a uniform height and driven by an a.c. generator. Under certain conditions, resonance is obtained. In this case a voltage is propagated along the line, due to its distributed self-inductance and the distributed capacitance from line to ground. The length of the line needed for resonance varies inversely with the frequency of the driving source. This idea can

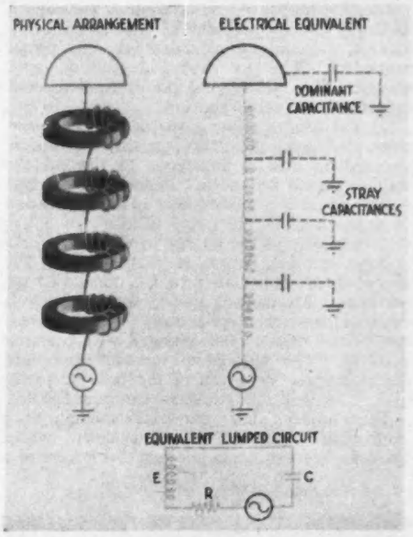


Fig. 20—Diagram of transmission-line accelerator principle

be adapted conveniently to the geometry of a particle accelerator, as shown diagramatically in the accompanying illustration (Fig. 20). "Lumped" inductance is introduced to the line in order to shorten the length needed for resonance. Core material is used to confine the losses so that the generator is physically compact. The circuit is enhanced by a dominant capacitance at the open end of the line, provided by the high-voltage terminal. Other important design aspects are: (1) the use of low-loss core segments; (2) the choice of a toroidal geometry for the core stack, both to reduce losses and to permit an easy incorporation of the acceleration-tube; and (3) the selection of an optimum frequency for resonance high enough to develop an intense average beam current without too large a magnetic loss.

The inherent simplicity of the design can be noted from the diagram. The acceleration tube is mounted coaxially with the toroidal segments. The line is tapped at convenient points to supply potential to the electrodes of the tube. The whole assembly is insulated with gas under

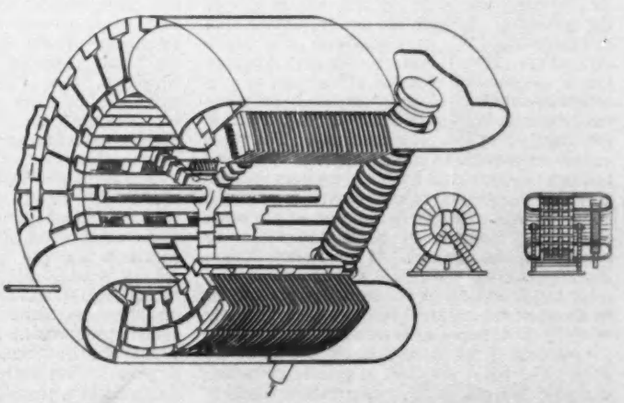


Fig. 21—Design of the proposed multiple-disc accelerator

THE AMERICAN SCENE *(Continued)*

pressure and housed in a tank. The line is driven by an external motor-generator or signal generator. The voltage cycle of this generator is a sine wave. Beam current is conducted over a narrow phase angle so that the voltage variation during the period of beam emission is small. Furthermore, the percentage loading of the circuit is so small that voltage drop during beam conduction is insignificant.

The first model of this accelerator is designed for 1 MeV and over 20mA of average beam current. It will be available for the power range of 10kW to 75kW, depending upon energy. The efficiency of power conversion is expected to be over 80 per cent.

(3) *The Multiple-Disc Accelerator.*—The principle of voltage generation in this machine is electrostatic and is analogous to that of the Van de Graaff generator. In the latter, charge is sprayed on to a moving belt by the application of a potential in the range of 10kV to 35kV. The belt conveys the charge to the inside of a hollow terminal, where it is removed. The charge flows immediately to the outside of the terminal. Mechanical power for the belt is obtained from a drive motor. The "down" run of the belt is often charged with opposite polarity. The amount of current developed depends upon the width of the belt, its speed, and on the field strength which can be supported.

The multiple-disc accelerator employs a multi-plate assembly of rigid discs, whose insulated sectors rotate between the sectors of a multi-plate stator. The surfaces of the discs are used to carry charge to the high-voltage side of the generator. A large amount of surface area can be obtained in a compact form. The drawing (Fig. 21) shows a design intended for a current of 10mA. The axis of the acceleration tube is at right angles to the rotor shaft because voltage potential is carried across the diameter of the plate assembly. The rotor sectors are charged by connecting them to ground through the peripheral drive as they pass through a set of stator sectors charged to a potential above ground. Charge is removed at the other end of the diameter by contact of the rotor sectors with the terminal. In the current design, mechanical drive is supplied through the central rotor shaft, and all of the rotor sectors carried by the shaft are insulated from it. The efficiency of electrical conversion is estimated to be about 35 per cent if the normal insulating gases are used. The beam produced is essentially monoenergetic, like that of other electrostatic accelerators. The expected power range of this accelerator is 25kW to 100kW. A first model is being constructed to deliver 15mA to 25mA at 1·5 MeV.

All of these three new designs involve the acceleration of more intense beams than those achieved before, and several concepts of use facilitate the design of accelerators for beam intensities above 25mA. The first concept is an extension of the existing techniques of beam deflection or diffusion. These techniques permit a more efficient use of the beam because a uniform surface dose is realised. Also, by spreading the beam over a greater surface area of the accelerator window, a higher beam current can be used without increasing the power density absorbed by the window. For example, the maximum power limit for an unscanned beam with a diameter of 1cm might be several hundred watts. But with a linear scan of 15in, this limit is increased to about 15kW. Another concept of processing is introduced by the use of very intense sources. The economy of large packages can best be realised by transmitting super-voltage power from one generator through insulated piping to independent multiple acceleration tubes, each of which draws an increment of the total power. The accelerated beams would be applied in a series of steps on one processing line, or to parallel lines. Radiation shielding would be greatly simplified, because it would be required only at the point of use. The power source and the transmission line would require only voltage insulation. This concept is more applicable to d.c. power as available from the insulating-core transformer or the multiple-disc generator, than to a.c. power. On the basis of known technology, solid dielectrics could be used for power transmission up to a level of about 1,000,000V and pressurised gas above this level. Techniques are available for independently switching any of the multiple acceleration tubes out of the line.

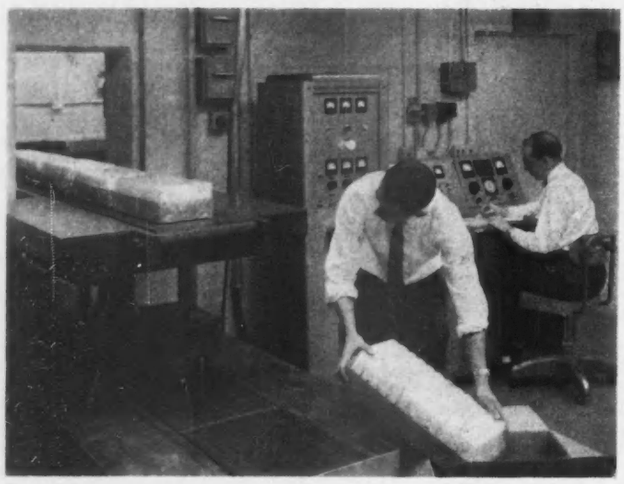


Fig. 22—Conveyor loading and unloading station and control console of 1·5 MeV Van de Graaff radiation processing facility

Radiation Processing Facility

More than thirty years ago, in Germany, Dr. Arno Brasch began his study of the effects of electron irradiation. After coming to the United States, he organised the Electronized Chemicals Corporation which gained broad experience in electron-beam processing because of extensive pioneering in electron irradiation techniques for the sterilisation and preservation of food and drugs and for irradiation chemistry. From 1949 to 1957, Electronized Chemicals operated an irradiation facility in Brooklyn, New York. This has now been superseded by a new radiation facility in Burlington, Massachusetts. The new facility is operated under contract with the High Voltage Engineering Corporation.

The radiation facility affords a convenient, economical means for carrying out a wide variety of experimental and developmental programmes to determine the value of penetrating radiation for any product or process. This facility is adaptable to a wide range of experimental, pilot-plant, and custom work in radiation chemistry and radiation sterilisation. The basic radiation source at the facility is a 1·5 MeV, 2·5kW Van de Graaff accelerator. The generator is mounted vertically, with its output normally delivered to a scanning system that provides an electron beam now having an effective width up to 30in. The equipment can be converted, in only a few minutes, to generate X-rays. It is easily possible to perform experiments with both electrons and X-rays in the same day.

The product-handling system comprises a belt conveyor and a quantity of aluminium trays that can be loaded, fed on to the conveyor, and unloaded outside the radiation room to facilitate continuous processing. For processes that require high radiation doses, the conveyor section directly under the scanner can be set to oscillate through distances from 12in to 60in for as long a time as may be necessary to obtain the desired radiation dose.

The accessory equipment includes: (*a*) a Beckman DU spectrophotometer for analysing absorption spectra of irradiated material; (*b*) a film winder for handling long lengths of plastic film in roll form; (*c*) a constant-temperature oven to condition samples both before and after irradiation; (*d*) an infra-red source for applying controlled heat during irradiation; (*e*) a deep freezer to store specimens that are to be irradiated in the frozen state and to facilitate work involving low-temperature reactions; and (*f*) a nitrogen cell to permit the irradiation of oxygen-sensitive materials in an inert atmosphere.

Under normal operating conditions, a radiation dose of 2×10^6 rads per pass is given to material in a processing tray under the electron beam. Since the maximum permissible product thickness for optimum dose uniformity is 0·20in of unit-density material, each tray can carry 1·6 lb. The processing rate is 16·6 lb per megarad per minute, or 1000 lb per megarad per hour. This is equivalent to 2900 square inches per minute of conveyor area at a dose of 1 megarad.

Fig. 22 shows the conveyor loading and unloading station with the machine control console: the heading picture (page 74, *ante*) portrayed a series of trays passing on a conveyor underneath the scanned beam.

In the United Kingdom further information on the electron-beam processing equipment reviewed is obtainable from the High Voltage Servicing Company, Chorley Wood, Rickmansworth, Herts.

Auxiliary Power for Rockets

A LIGHTWEIGHT source of electric power to drive the guidance, control, and other auxiliary services of rocket vehicles was disclosed recently by the Radio Corporation of America and the Hunter-Bristol Division of Thiokol Chemical Corporation. A 3½ lb experimental unit fitted around the flame tube of a solid-propellant motor has produced up to 270W.

The device bears a family resemblance to conventional two-element electron tubes or diodes, in having a cathode from which electrons are "boiled" by the application of heat, and another electrode to which these electrons flow to produce an electrical output.

In the experimental tube for rocket application, the cathode is formed by the inner wall of a hollow cylinder, while the second electrode is formed by the outer wall. Between the two walls is a narrow space filled with cesium vapour. When the cathode wall is heated by the burning rocket fuel in the flame tube, electrons are "boiled" out of the cathode material and into the space between the two walls. The cesium vapour that occupies this space becomes ionised upon contact with the hot cathode, and encourages the easy flow of electrons to the outer wall. The electrical power that is generated by this process is fed to the rocket steering control mechanism or to electronic apparatus by means of cables attached to the cathode and the second electrode.

The size and shape of the experimental tube were designed specifically for the Thiokol test installation in order to study the feasibility of the system; the design of eventual operating types of thermionic generator tubes would vary in accordance with the various designs of the rockets in which they might be used.

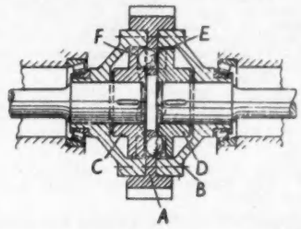
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

MOTOR VEHICLES

824,739. August 15, 1957.—DIFFERENTIAL GEARINGS, PARTICULARLY FOR MOTOR VEHICLES, Daimler-Benz Aktiengesellschaft, Stuttgart-Untertürkheim, Germany.

The principal object of the invention is to provide a differential gearing of simplified construction so that the manufacture of individual parts and assembly can be carried out simply and cheaply. As shown in the drawing the central driving wheel *A*



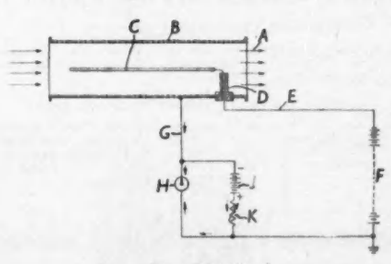
No. 824,739

is enlarged by the shells on either side to form a drive housing, which may be mounted as a unit in an axle housing. In the housing, the driven bodies *C* and *D* are fixed on the half shafts. The driving wheel has bores passing through it, in which the balls *E* are slidable in the axial direction. The driven bodies *C* and *D* are provided with sine curve tracks which lie on both sides, and next to the bores, of the driving wheel. The tracks have a plane running surface *F* in axial section. Their pitches are different so that, for example, the track of the body *C* has five turns and the track *D* has six turns. Accordingly, eleven points of intersection are obtained between the two tracks at a constant distance from one another and the driving wheel must also have eleven openings with eleven balls. In operation the driving wheel transmits the torque to the balls, which in turn transmit it to the two driven bodies by bearing against their sine curve tracks. Under these circumstances there is normally no relative movement between the driven bodies. When the vehicle travels on a curve compensation of the speeds of rotation of the two driven bodies with respect to one another can take place due to the fact that the balls move axially in their openings and hence the driven bodies are turned relative to one another in consequence of the different pitches of the sine curve tracks.—*December* 2, 1959.

INSTRUMENTATION

826,195. May 30, 1957.—DETECTING OR MEASURING THE CONTENT OF FINE PARTICLES IN A FLOWING FLUID, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor : Duncan Holmes Grindell.*)

The invention is based on the phenomenon that the particles absorb from a corona discharge through the fluid an electric charge which is proportional to their total surface area and which causes a corresponding change in the current flowing in an external circuit feeding the corona discharge. According to the preferred embodiment illustrated, a flow of fluid *A*, the particle content of which has to be determined, is passed through a channel having an electrically conducting wall *B*, such as a metal cylinder. An electrode, *C*, of elongated shape, such as a metal wire or filament, is supported by the wall through the intermediary of an insulating bushing *D* so as to be positioned co-axially with the cylinder. A lead *E* which in this case is introduced into the channel through the bushing, serves for connecting one pole of a high voltage source *F*, of 8kV for instance, to the electrode *C*. Another lead *G* connects the wall of the cylinder to a current measuring instrument *H*, such as a microammeter or a milliammeter via an amplifier if required. A low voltage battery *J* and a variable series resistor *K* are provided to form a shunt circuit in relation to the instrument *H*. The polarity of the battery is such as to feed to the instrument direct current, the direction of which is opposite to the flow of current through the instrument due to the corona discharge between the electrode and wall when no particle stream passes through the cylinder, and the resistor can be adjusted to cause under these conditions a zero reading on the instrument. A subsequent reading can, in theory, be simply related to the actual rate of flow of particles suspended in the fluid.—*December* 31, 1959.

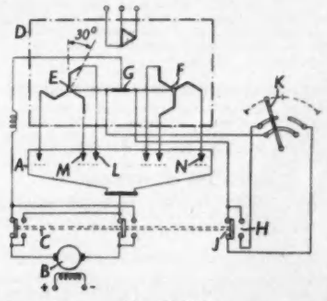


No. 826,195

ELECTRICAL ENGINEERING

826,188. April 12, 1957.—MERCURY ARC RECTIFIER-INVERTER EQUIPMENTS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor : John Carley Read.*)

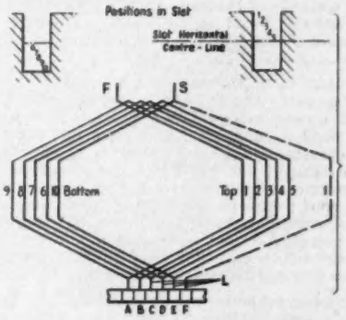
This invention relates to mercury arc rectifier-inverter equipments for supplying variable speed d.c. motors, particularly those for electric winders, of the kind in which a common set of rectifying valves and a common set of transformer windings are employed alternatively for rectification to supply power to the motor and for inversion to return power from the motor to the a.c. supply. According to the invention, a pair of star-connected secondary windings of the transformer which supply operating voltage to the anodes of the rectifying valves, and which are connected in parallel by the interphase transformer short-circuited during inversion, are zigzag connected, so that the commutating reactance between anodes 60 deg. apart is considerably less than the commutating reactance between anodes 120 deg. apart, thereby reducing the excessive angle of overlap obtained during inversion. Referring to the drawing, a grid-controlled mercury arc rectifier *A* supplies a d.c. winder motor *B* through a double-pole armature reversing switch *C*. The secondary windings of the rectifier transformer *D* which are connected to the anodes comprise two three-phase stars *E* and *F*, electrically displaced apart by 180 deg., which are connected in parallel by the interphase transformer *G* between their star points. Auxiliary contacts *H* and *J* on the reversing switch co-operate with contacts on the controller *K* to short-circuit the interphase transformer under certain conditions. The secondary stars *E* and *F* are zigzag connected. When it is desired to retard the motor by changing over to inversion the reversing switch is thrown over to the right. This simultaneously causes contact *H* to short out the interphase transformer so long as inversion continues. When next the winder motor starts from rest in the opposite direction, switch *C* is still thrown to the right, but controller *K* being thrown to the right causes the interphase transformer to be no longer shorted out, until a fresh need for inversion causes the reversing switch to move to the left. During rectification, i.e. with the interphase transformer not shorted, commutation of the current takes place between anodes 120 deg. apart, e.g. from anode *L* to anode *M*, but during inversion, with the interphase shorted, commutation takes place between successive anodes 60 deg. apart, e.g. from anode *L* to anode *N*. If the star-connected windings, *E* and *F* had not been zigzag connected, these two values of commutating reactance would have been equal, and this would have caused the angle of overlap, i.e. the angular time required to commutate the current from anode to anode, to be excessively large when inverting. This would have resulted in unnecessarily low power factor when rectifying at the same d.c. voltage. However the zigzag connection shown reduces the commutating reactance between anodes 60 deg. apart to about one-third of the value obtained between anodes 120 deg. apart, and thus avoids this detrimental effect.—*December* 31, 1959.



No. 826,188

826,138. February 16, 1956.—ARMATURE COILS FOR DYNAMO ELECTRIC MACHINES, George Herbert Fletcher, Garbridge Hotel, Appleby, Westmorland.

In Specification No. 792,428, an armature coil is described in which the turns are concentric, i.e. equally spaced from the central cross-plane. The start and finish of a coil are in positions remote from the commutator end and tappings are taken from the noses of the coil. This has the effect of upsetting the desired symmetry so that in an armature wound with such coils, the reactance voltages of the various coils when undergoing commutation would be unequal and sparking at the commutator might result. According to the present invention, in an armature coil as described, the desired object is achieved by suitably transposing a slot conductor of each coil so that turn conductors connected to short-circuited commutator segments lie in their slots in desired positions, that is, each of the turn conductors lies symmetrically in the slot with reference to the slot horizontal centre-line. The figure shows by way of example how a coil in accordance with the invention may be wound. Points *S* and *F* are the start and finish of the coil, and tappings *L* are taken from each conductor at the opposite end or nose, each tapping being connected to a commutator segment *A*, *B*, *C*, *D*, &c. The conductors marked 6, 7, 8, 9, and 10 lie at the bottom of one slot and conductors 1, 2, 3, 4, and 5 lie at the top of another slot governed by the coil-pitch. In this arrangement, the conductor marked 10 is the transposed conductor. Pairs of conductors which make the coil as connected to the commutator bars will be paired as follows : 5 and 6, 4 and 7, 3 and 8, 2 and 9, and these are symmetrical about the slot horizontal centre-line. The conductor marked 1 will be connected at the front end to the conductor marked 10 of the adjacent coil on one side while the conductor marked 10 will be connected to the conductor marked 1 of the adjacent coil on the other side, thus providing the fractional pitch which is one of the advantages claimed for this type of winding.—*December* 31, 1959.



No. 826,138

826,253. August 2, 1956.—VOLTAGE REGULATING DEVICE, Claude Lyons, Ltd., 76, Old Hall Street, Liverpool, 3, and Stephen Brod, of the Company's address.

According to the present invention a voltage regulating device for connection to a mains supply includes a transformer having a tapped primary winding, a selector switch for selecting tapping points on the primary, and a control circuit responsive to variations in the voltage to be regulated. The control circuit illustrated in the specification employs gas-filled, grid-controlled valves connected in such a manner that the operation of one valve

acts on an electromagnetic ratchet mechanism so that the tapping selector switch increases the regulated voltage, while the second valve has the reverse effect. The control circuit is preferably a bridge circuit in which a voltage indicative of the regulated voltage is balanced against a reference or standard voltage. Alternatively a resistance which varies with the regulated voltage may be connected in one arm of the bridge.—*December* 31, 1959.

Launches and Trial Trips

QUILOA, oil tanker ; built by Scotts Shipbuilding and Engineering Company, Ltd., for the British India Steam Navigation Company ; length between perpendiculars 534ft, breadth moulded 71ft 8in, depth moulded 39ft 6in, 19,045 tons deadweight on 30ft 2in summer draught ; twenty-seven cargo oil tanks, two pump rooms, two 550kW turbine-driven alternators, one 200kW diesel-driven alternator ; one set of double-reduction geared turbines of 8000 s.h.p., service speed 14½ knots. Launch, November 3.

CRYSTAL SAPPHIRE, cargo ship ; built by Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., for Sugar Line, Ltd.; length between perpendiculars 460ft, breadth moulded 65ft, depth moulded 39ft 6in, deadweight 11,450 tons, summer draught 27ft ; five centre line holds with wing spaces at Nos. 2, 3, 4 and 5, one 25-ton and ten 10-ton derricks, steam deck machinery ; one 75kW steam-driven and two 240kW diesel-driven generators ; Hawthorn-Doxford five-cylinder oil engine, 5500 b.h.p. at 112 r.p.m. Launch, November 3.

BRITISH MALLARD, oil tanker ; built at Belfast by Harland and Wolff, Ltd., for B.P. Tanker Company, Ltd.; length between perpendiculars 495ft, breadth moulded 69ft, depth moulded 37ft, deadweight on summer draught 15,500 tons ; twenty-seven cargo oil tanks, two cargo pump rooms ; two 250kW diesel-driven generators, one 75kW steam-driven generator, one exhaust gas-fired and two oil-fired boilers ; Harland and Wolff opposed piston oil engine, six cylinders 750mm diameter by 2000mm combined stroke. Launch, November 3.

MOBILE ACME, oil tanker ; built by Alexander Stephen and Sons, Ltd., for Mobil Tankships, Ltd.; length between perpendiculars 525ft, breadth moulded 74ft, depth moulded 39ft, deadweight 18,300 tons on 30ft draught, service speed 15½ knots ; twenty-seven cargo oil tanks, four 2000 gallons per minute turbine-driven cargo oil pumps, two 500kVA turbine-driven generators ; one set two-cylinder cross compound, double-reduction geared turbines of 9250 s.h.p. at 108 propeller revolutions per minute, two Foster-Wheeler E.S.D. boilers provide steam at 600 lb per square inch and 850 deg. Fah. Launch, November 3.

ELLENGA, oil tanker ; built at Wallsend by Swan, Hunter and Wigham Richardson, Ltd., for the British India Steam Navigation Company, Ltd.; length between perpendiculars 660ft, breadth moulded 90ft, depth moulded 48ft, deadweight 37,000 tons on 36ft 4in draught, service speed 16 knots ; thirty-three cargo oil tanks, one cargo pump room, four 1350 tons per hour turbine-driven Drysdale centrifugal oil pumps, two 330 tons per hour stripping pumps ; two 750kW turbine-driven alternators, one 200kW diesel-driven alternator ; one set of Wallsend Slipway geared turbines of 16,000 s.h.p. at 105 propeller revolutions per minute, steam supplied at 600 lb per square inch and 850 deg. Fah. by two Babcock and Wilcox boilers. Launch, December 1.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Jan. 22.—STOKE AND CREWE BRANCH : Royal Hotel, Crewe, "Earthing and Earth Leakage Protection of Electrical Installations," J. A. Robbins, 7.30 p.m.
Mon., Jan. 25.—NORTH WEST LONDON BRANCH : Compass Hotel, Watford, "Control Gear," R. F. Mathieson, 8.15 p.m.
Tues., Jan. 26.—EAST KENT BRANCH : Clarendon Hotel, Broadstairs, "The Decca Navigational System," B. A. A. Smye-Rumsby, 8 p.m. ★ NEWCASTLE UPON TYNE AND DISTRICT BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, Colour film of the 1959 Electrical Engineers (A.S.E.E.) Exhibition and travel films, 7.30 p.m.
Thurs., Jan. 28.—BRIGHTON, HOVE AND DISTRICT BRANCH : New Imperial Hotel, First Avenue, Hove, "Switchgear Testing," R. Jones, 7.30 p.m. ★ SOUTHAMPTON BRANCH : Polygon Hotel, Southampton, "Impregnating Varnishes and Wire Enamels," K. B. Smith, 8 p.m. ★ SOUTH LONDON BRANCH : Greyhound Hotel, High Street, Croydon, Surrey, "The Work of the Royal Mint Refineries," J. T. McEvoy, 8 p.m.
Fri., Jan. 29.—COVENTRY AND DISTRICT BRANCH : E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, Coventry, Visit by C. G. F. Aldridge (National Chairman), and E. A. Bromfield (General Secretary), 7.45 p.m.

BRITISH COMPUTER SOCIETY

Wed., Jan. 27.—LONDON BRANCH : Northampton College of Advanced Technology, St. John Street, London, E.C.1, "Storage Elements for Very High Speed Computers," G. G. Macfarlane, 2.30 p.m.
Thurs., Jan. 28.—SOUTH WALES AND MONMOUTHSHIRE BRANCH : Small Shandon Lecture Theatre, University College, Cardiff, "Basic Principles of Programming," Part I, R. J. Ord-Smith, 6.30 p.m. ★ LIVERPOOL BRANCH : Mathematical Institute, The University, Liverpool, "Avoiding Mistakes by Oversight in an Industrial Programme," A. Young, 6.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

To-day, Jan. 22.—SCOTTISH SECTION : Department of Natural Philosophy, The University, Drummond Street, Edinburgh, "Micro Miniaturization," H. G. Manfield, 7 p.m.
Wed., Jan. 27.—LONDON BRANCH : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, "Training for Operating and Maintaining Television Broadcasting Equipment," K. R. Sturley and A. E. Robertson, 6.30 p.m. SOUTH WESTERN SECTION : School of Management Studies, Unity Street, Bristol, "An Equipment for Automatically Processing Time Multiplexed Telemetry Data (Timtape)," J. H. Russell, N. Purnell, and T. T. Walters, 7 p.m.

CEMENT AND CONCRETE ASSOCIATION

Thurs., Jan. 28.—Technical and Art College, Bell Street, Wakefield, "Practical Formwork Design and Construction for Concrete," J. G. Richardson, 7.15 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Tues., Jan. 26.—NORTH WESTERN REGION : Engineers' Club, Albert Square, Manchester, "The Utilisation of Steam and Heat," R. Clare, 2.30 p.m.
Wed., Jan. 27.—SCOTTISH REGION : Royal British Hotel, 20, Princes Street, Edinburgh, Discussion on "The Utilisation of Waste Products as Fuel," opened by H. A. Mercer, 10.30 a.m.; Discussion on "Fuel Saving Schemes," opened by R. Bunting, 2 p.m.
Thurs., Jan. 28.—WESTERN REGION : Park Hotel, Cardiff, Discussion on "Factors Affecting the Choice of New Boiler Plant," opened by W. Short, 11 a.m. and 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., Jan. 25.—LEEDS CENTRE : British Lighting Council, 24, Aire Street, Leeds, 1, "Some Recent Developments in Street Lighting," N. Burgess, 6.15 p.m. ★ LEICESTER CENTRE : Demonstration Theatre, East Midlands Electricity Board, Charles Street, Leicester, "Recent Developments in Light Sources," D. H. Holloway, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Jan. 27.—LONDON BRANCH : Constitutional Club, Northumberland Avenue, London, W.C.2, Apprentices' Evening, "Special Problems," with special reference to the International Apprentice Competition, compered by A. Talbot, 7.30 p.m.

INSTITUTE OF SHEET METAL ENGINEERING

Wed., Jan. 27.—WOLVERHAMPTON SECTION : Wolverhampton and Staffordshire College of Technology, Wulfruna Street, Wolverhampton, "High Speed Blanking and Piercing and the Production of Laminations," N. V. Larking, 6.45 p.m.

INSTITUTE OF WELDING

Wed., Jan. 27.—MEDWAY SECTION : Medway College of Technology, Chatham, Demonstration of "New Welding Processes," 2–4.30 p.m. and 6.30–9 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Jan. 26.—NORTH WESTERN BRANCH : Chemical Engineering Lecture Theatre, Manchester College of Science and Technology, Jackson Street, Manchester, "Rotating Band and Spinning Band High Vacuum Distillation," 6.30 p.m.
Fri., Jan. 29.—NORTH WESTERN BRANCH : Midland Hotel, Manchester, Annual General Meeting, 3.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Jan. 26.—Great George Street, Westminster, London, S.W.1 "The Planning and Design of Maintenance Bases for Civil Aircraft," E. O. Measor, L. B. Haley and A. J. Harris, 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Jan. 25.—EAST ANGLIAN SUB-CENTRE : Electric House, Ipswich, "Radio Interference from H.V. Insulators," C. H. W. Clark, 6.30 p.m. ★ NORTH-EASTERN CENTRE : Neville Hall, Westgate Road, Newcastle upon Tyne, "Field Suppression of Turbo-Alternators," J. R. Hill, A. Hunt, W. J. Joyce and D. H. Tompsett, 6.15 p.m.
Wed., Jan. 27.—ELECTRONICS AND COMMUNICATIONS SECTION : Savoy Place, London, W.C.2, "The Oral Presentation of Scientific Material," A. Clow, 5.30 p.m. ★ EAST MIDLAND CENTRE : College of Arts and Crafts, Waverley Street, Nottingham, "D.C. Winder Drives Using Mercury-Arc Rectifier/Inverters," L. Abram, J. P. McBreen and J. Sherlock, 6.30 p.m.
Thurs., Jan. 28.—ORDINARY MEETING : Savoy Place London, W.C.2, "Radio Communications by Means of Satellites," A. W. Lines, 5.30 p.m. ★ MERSEY AND NORTH WALES CENTRE : M.A.N.W.E.B. Service Centre, Buttermarket Street, Warrington, "The Electrification of the U.K.A.E.A. Industrial Group Factories," J. W. Binns and W. J. Outram, 6.30 p.m. ★ SCOTTISH CENTRE DIAMOND JUBILEE : Bute Hall, The University, Glasgow, Conversazione, 7.30 p.m.
Fri., Jan. 29.—ELECTRONICS AND COMMUNICATIONS SECTION : Savoy Place, London, W.C.2, "Beam-Type Parametric Amplifiers : Some Aspects of Design and Use," R. B. Dyott and C. R. Russell, 5.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Jan. 26.—39, Elmbank Crescent, Glasgow, Joint Meeting with the Scottish Section of the Institute of Marine Engineers, "Some Aspects of Marine Reactor Safety," K. Maddocks, 6.30 p.m.
Wed., Jan. 27.—University College, Dundee, Joint meeting with Dundee Institute of Engineers, "Marine Nuclear Propulsion—a Recent Survey," K. Maddocks, 7.15 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, Jan. 22.—NORTHERN BRANCH : The Courts, Carlisle, "Dry-lean Concrete—Theory and Practice," D. R. Sharp and J. M. Fisher, 6.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Tues., Jan. 26.—AUTOMOBILE DIVISION : 1, Birdcage Walk, Westminster, London, S.W.1, Discussion on "Problems of Maintaining Silence in Passenger Cars," 6 p.m.
Wed., Jan. 27.—THOMAS LOWE GRAY LECTURE : 1, Birdcage Walk, Westminster, London, S.W.1, "Technical and Economic Aspects Covering the Ocean Transportation of Liquid Methane," J. J. McMullen, 6 p.m.
Thurs., Jan. 28.—NORTH WESTERN BRANCH : Engineers' Club, Albert Square, Manchester, Election of Committee ; "Design and Utilisation of Fork Truck Equipment," E. P. Dinsdale, 6.45 p.m. EASTERN GRADUATES' SECTION : Old Manor House, St. Margaret's Green, Ipswich, "Railway Development," J. Foreman, 7.30 p.m. ★ EAST MIDLANDS GRADUATES' SECTION : College of Art, Green Lane, Derby, Film Show, 7.15 p.m.
Sat., Jan. 30.—EAST MIDLANDS GRADUATES' SECTION : Visit to Worthington-Simpson, Ltd., Lowfield Works, Newark, 10 a.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Jan. 25.—EAST AND WEST RIDINGS REGION : Technical College, Huddersfield, "Production Engineering Education," R. Shilton, 7.30 p.m. ★ SHEFFIELD GRADUATE SECTION : Naval Ordnance Inspection Establishment, Jensen Street, Sheffield, 9, "The Generation and Measurement of Fine Surface Finishes," K. J. Croxen, 6.30 p.m. ★ NORTH WESTERN REGION : Reynold's Hall, Manchester College of Science and Technology, Sackville Street, Manchester, "Practical Applications on Operational Research," A. J. R. Veale, 7.15 p.m. ★ NORTH WESTERN REGION : Grand Hotel, Hanley, Stoke-on-Trent, "Materials Handling—A Challenge to British Industry," A. G. Hayek, Film, "Time, Space and Effort," 7.30 p.m.
Wed., Jan. 27.—MIDLANDS REGION : Technical College, Oakengates, Shrewsbury, "Automatic Transfer Machines," R. Cadwallander, 7.30 p.m. ★ SOUTH EASTERN REGION, LONDON-BRIGHTON GROUP : Old Ship Hotel, Brighton, "Recent Developments in Sintered Oxide Cutting Materials," R. N. Cook, 7 p.m.
Thurs., Jan. 28.—NORTH MIDLANDS REGION : Ruston Club, Lincoln, "Some Aspects of Production Engineering," L. R. Mumford, 7.30 p.m.

INSTITUTION OF THE RUBBER INDUSTRY

Mon., Jan. 25.—MANCHESTER SECTION : Newton Heath Technical College, Manchester, "Developments in the Preservation and Testing of Latex," M. W. Philpott, 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Jan. 22.—MIDLAND COUNTIES BRANCH : James Watt Memorial Institute, Birmingham, "Modern Methods of Fabricating Structural Steelwork," M. F. Palmer and R. J. Fowler, 6.30 p.m.
Thurs., Jan. 28.—11, Upper Belgrave Street, London, S.W.1, "The Structural Engineer in the Field of Atomic Energy," T. C. Waters, 6 p.m. ★ NORTHERN COUNTIES BRANCH : Cleveland Scientific and Technical Institution, Middlesbrough, Joint Meeting with the Tees-side Branch of the Institution of Civil Engineers, "Economics of Framed Structures," L. R Creasy, 6.15 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Jan. 22.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Developments in Engineering Education, Recently and to Come," H. L. Haslegrave, 7 p.m.
Fri., Jan. 29.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Ceramics," A. Dinsdale, 7 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

Fri., Jan. 29.—Engineers' Club, Albert Square, Manchester, 2, "The Development and Application of Lightweight Sandwich Structure," H. R. Ashley, 6.45 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Tues., Jan. 26.—12, Great George Street, Parliament Square, London, S.W.1, "Traffic Congestion : Its Causes and Consequences—Some Effects on Land Values," C. T. Brunner, 5.45 p.m.

ROYAL INSTITUTION OF NAVAL ARCHITECTS

Tues., Jan. 26.—Institute of Marine Engineers, 76, Mark Lane, London, E.C.3, "Control and Instrumentation of Marine Reactors," R. Anscomb and F. Hutber, 5.30 p.m.

ROYAL METEOROLOGICAL SOCIETY

To-day, Jan. 22.—MANCHESTER CENTRE : The University, Manchester, "Evaporation from the Oceans and from Lakes," J. L. H. Sibbons, 5.45 p.m.
Fri., Jan. 29.—SCOTTISH CENTRE : Department of Natural Philosophy, Drummond Street, Edinburgh, "Some Meteorological Aspects of Air Pollution," P. J. Meade, 5 p.m.

ROYAL SOCIETY

Thurs., Feb. 4.—Burlington House, Piccadilly, London, W.1, Discussion on "The Results of The Royal Society I.G.Y. Expedition," opened by Sir Graham Sutton, 10.30 a.m.

ROYAL STATISTICAL SOCIETY

Thurs., Jan. 28.—LEICESTER GROUP : Room 104, Leicester College of Technology, The Newark, Leicester, "The Analysis of Censored Data," J. Taylor, 7 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Jan. 26.—Manson House, 26, Portland Place, London, W.1, Symposium on Flame Failure Detection, "A Review of Current Flame Failure Devices," D. H. Surgeoner ; and "Applications of Flame Failure Equipment," D. Richards, 7 p.m.

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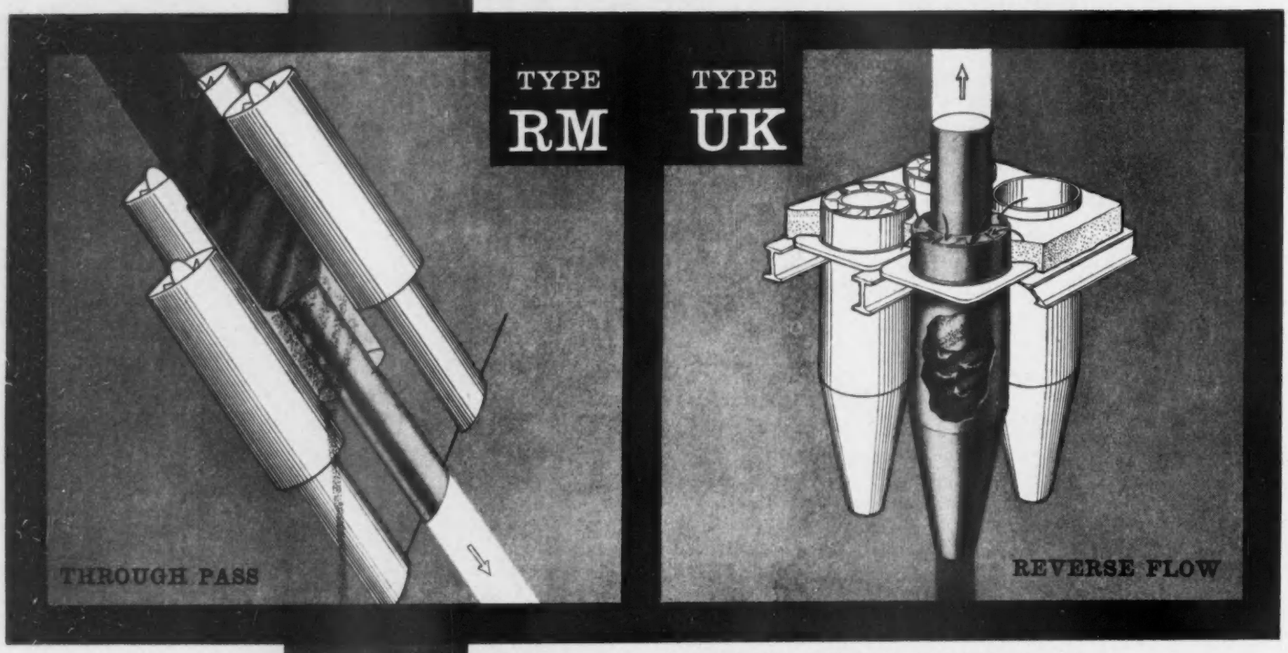

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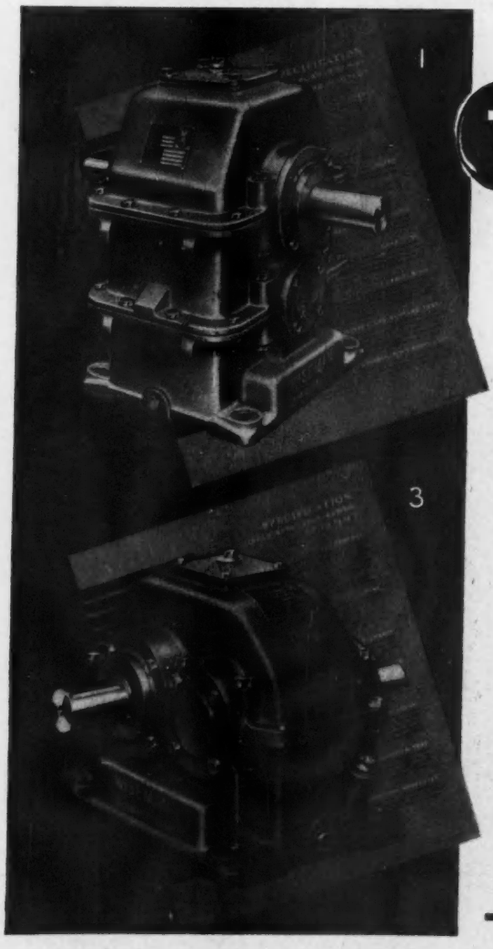

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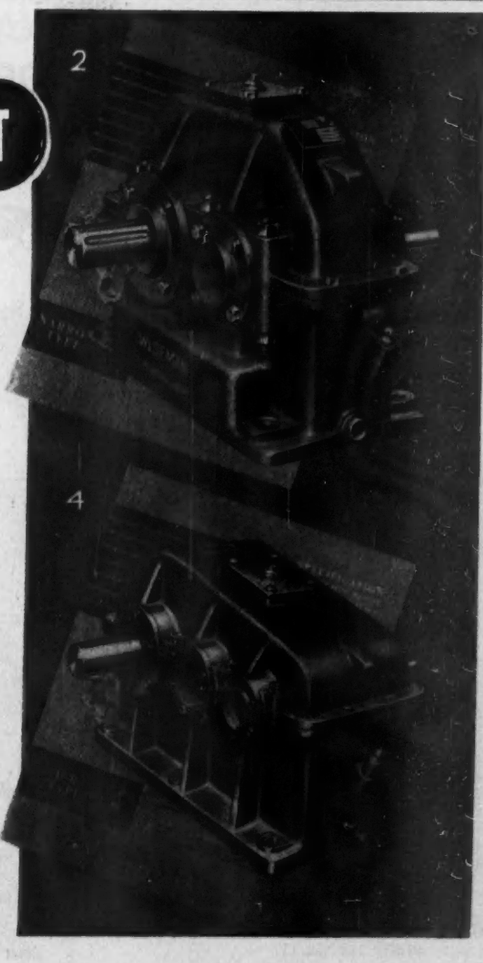

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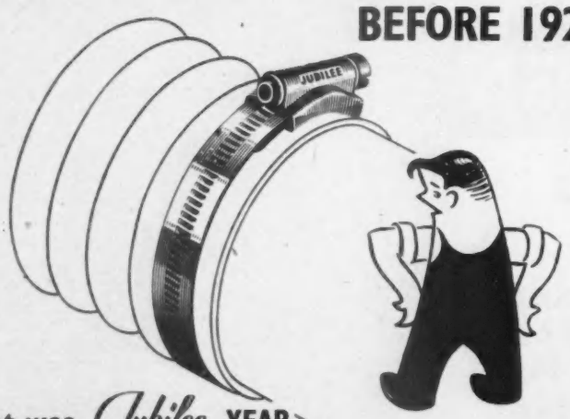

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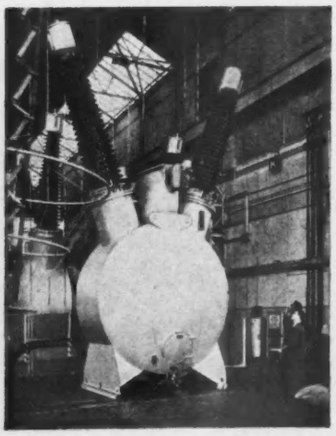

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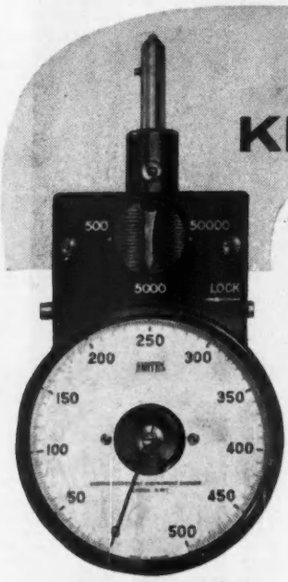

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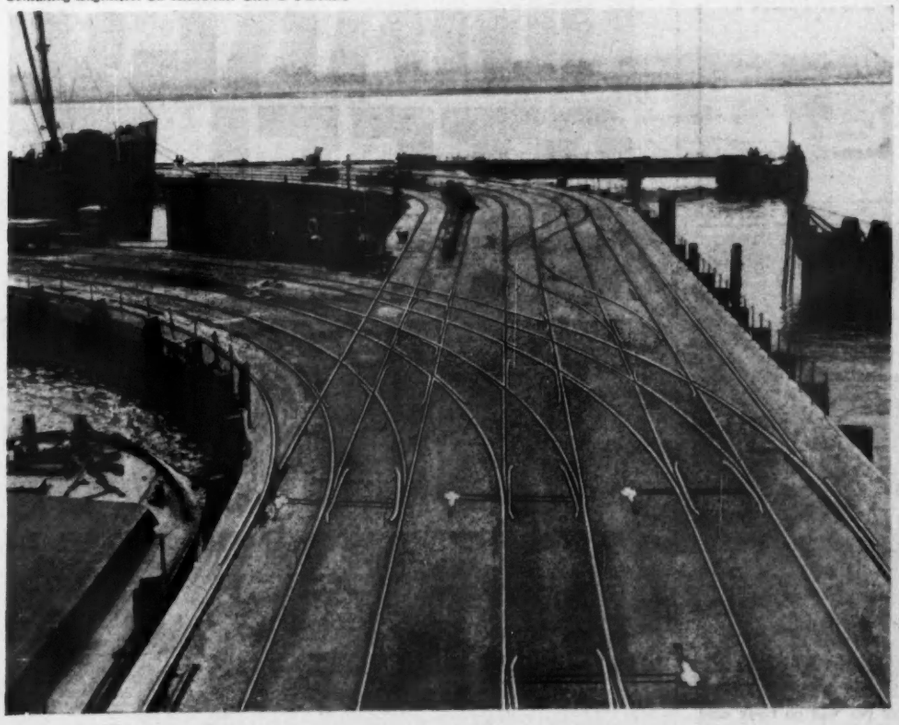

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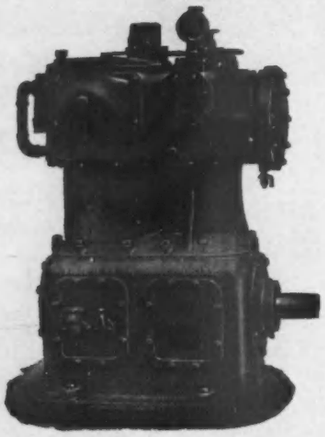

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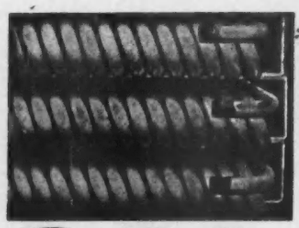

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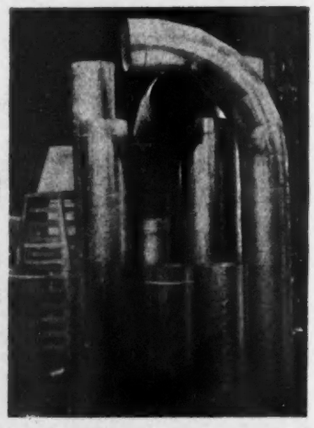

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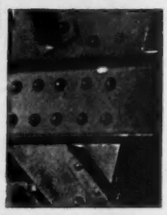

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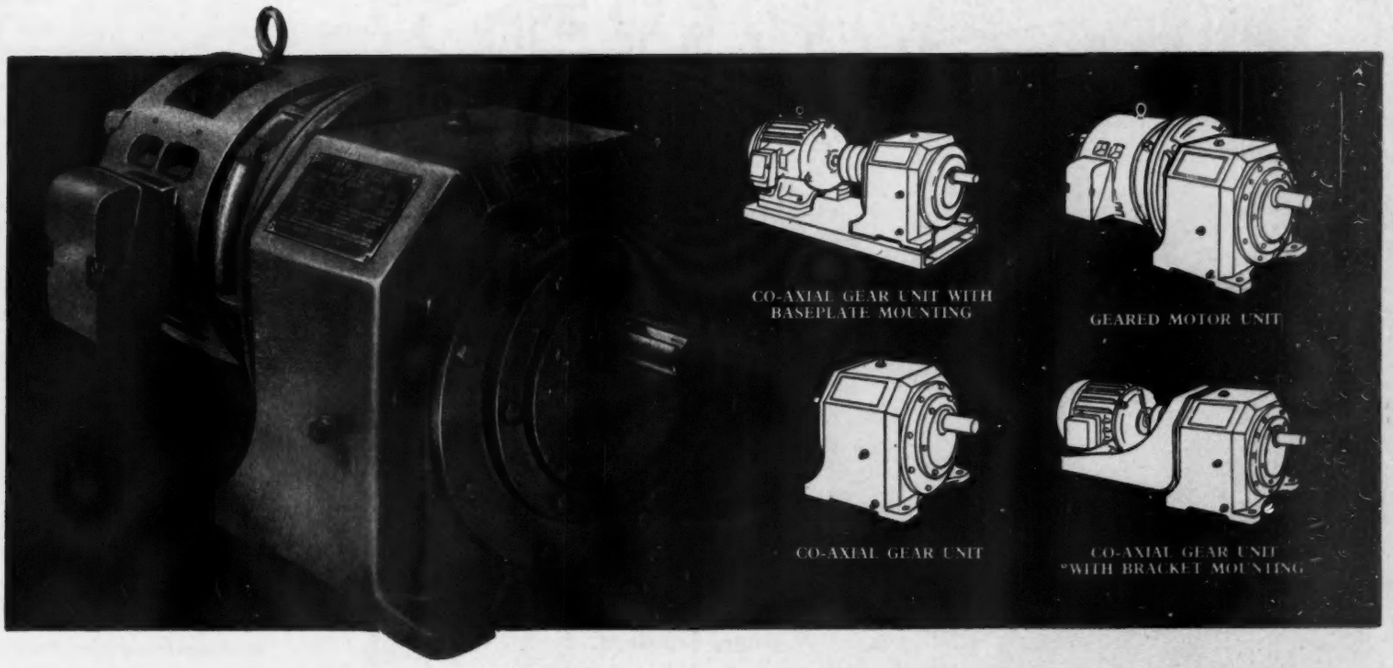
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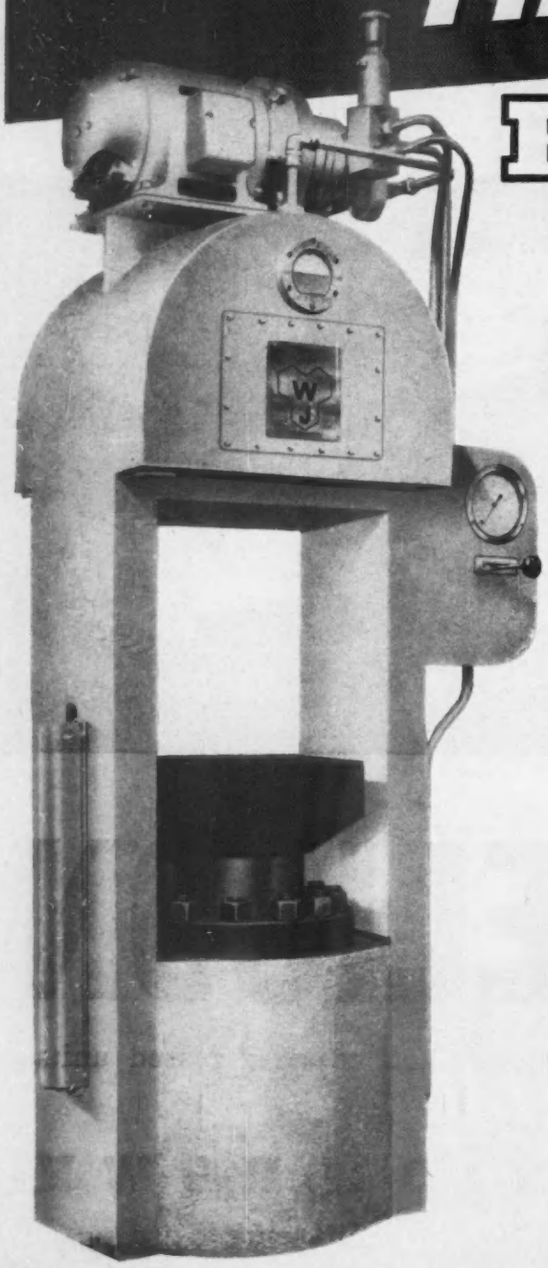

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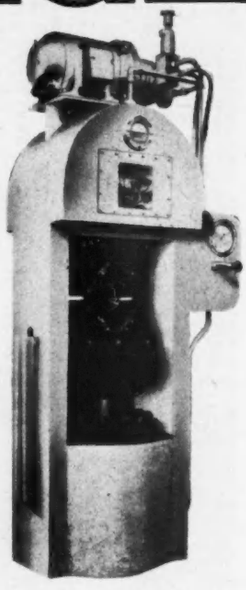

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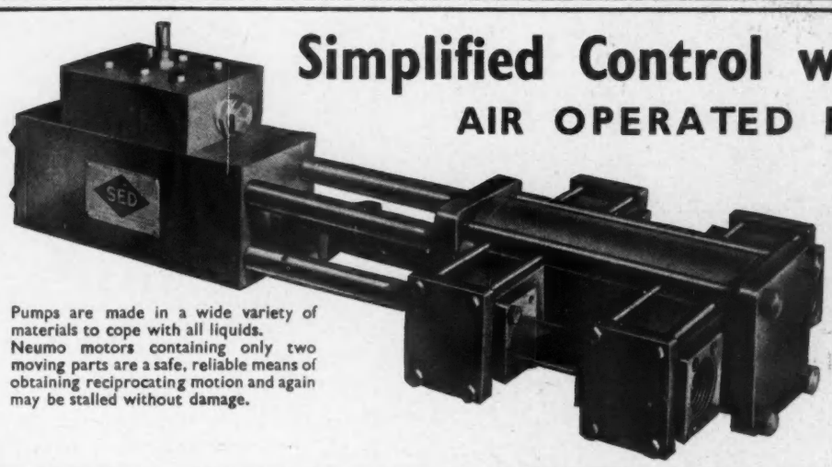

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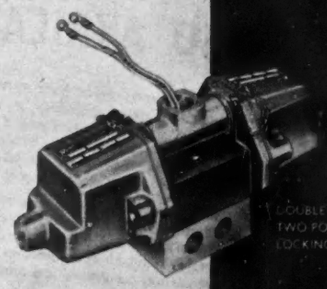

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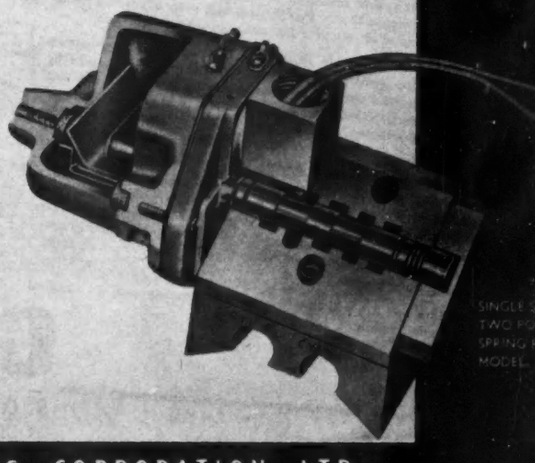

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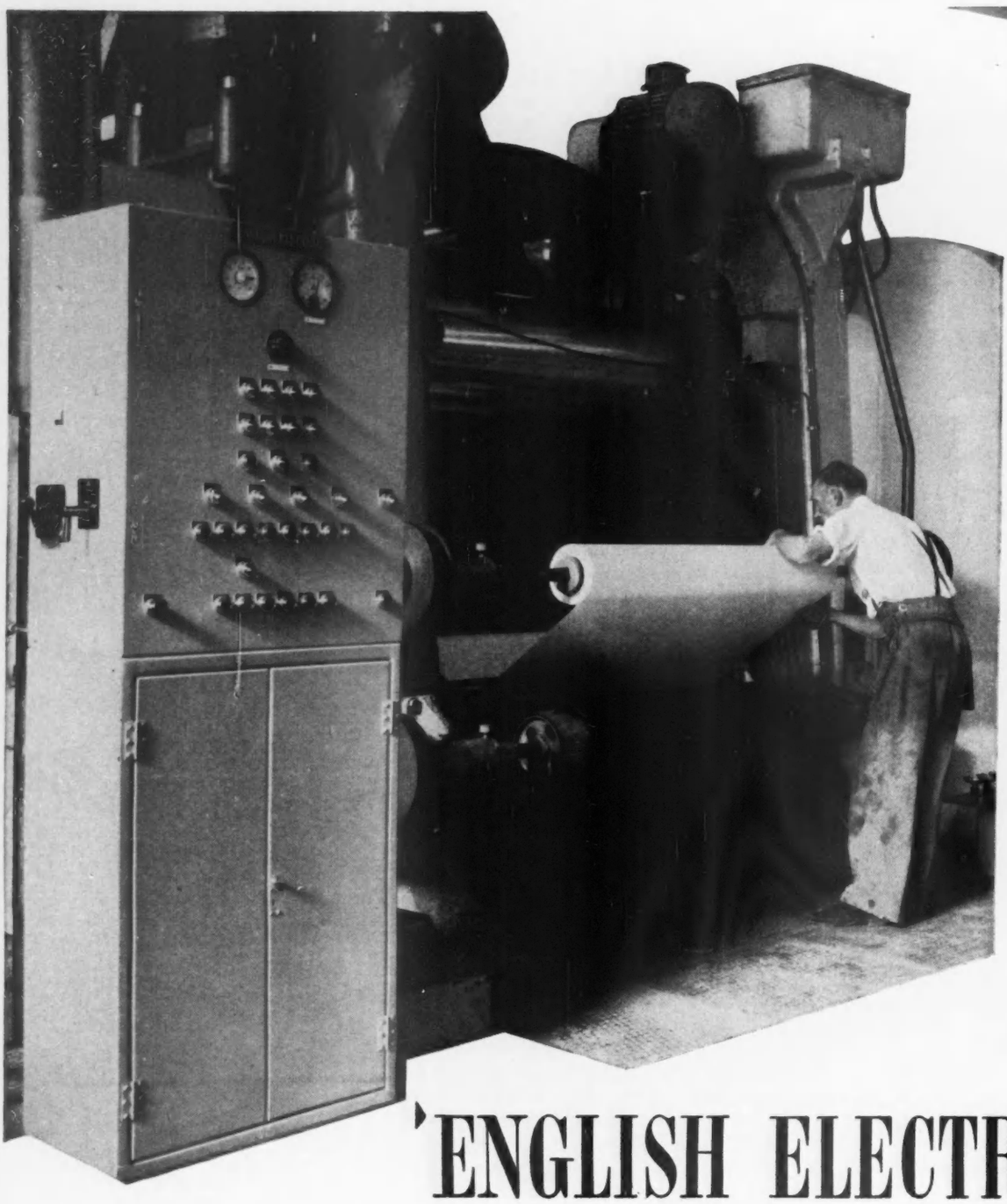

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Four rubber mills, the tyre calender and hose calender and their auxiliaries in the new extension at the Edinburgh factory of The North British Rubber Company Limited are powered and controlled by 'ENGLISH ELECTRIC'.

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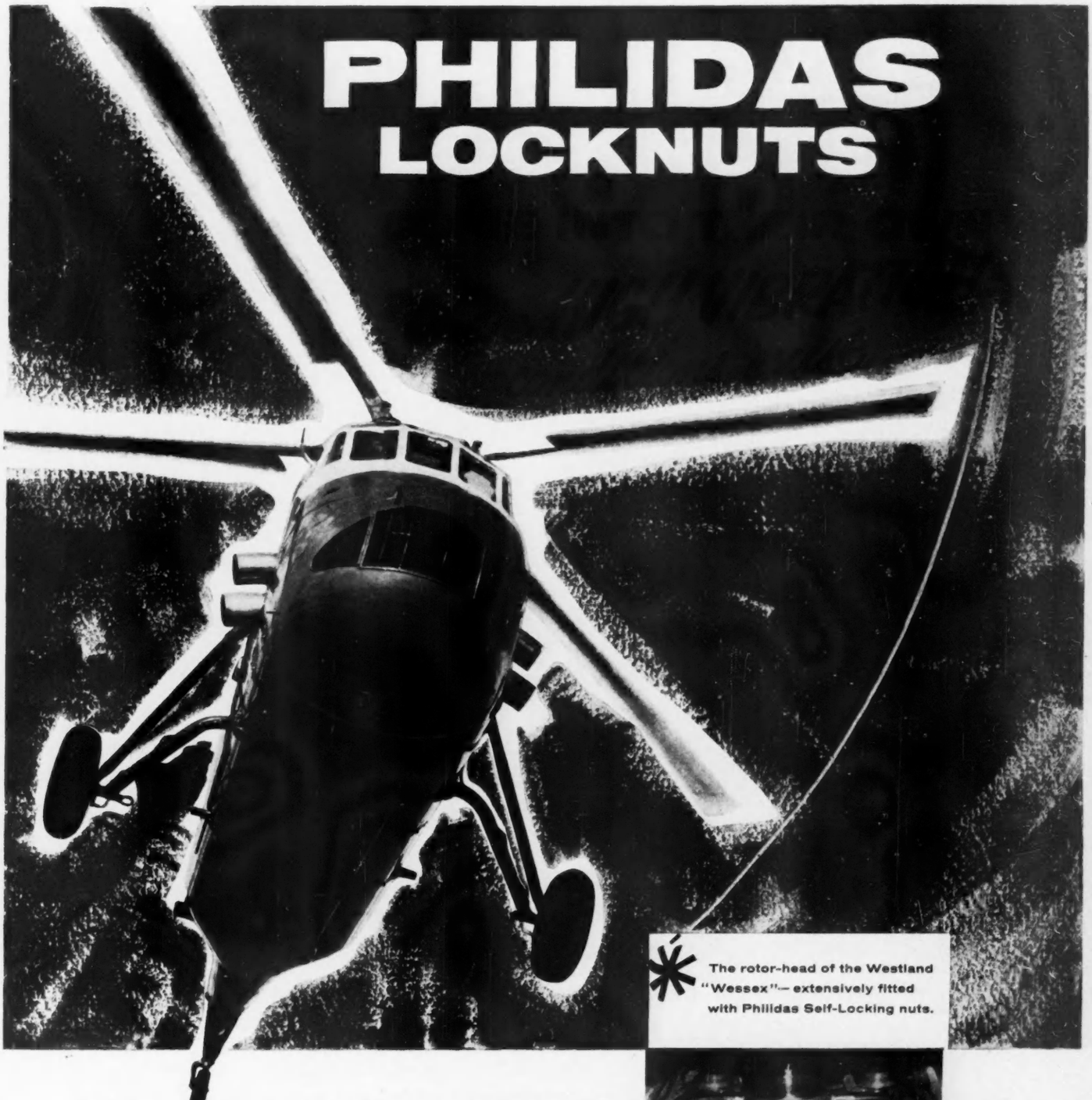

* The rotor-head of the Westland "Wessex"— extensively fitted with Philidas Self-Locking nuts.

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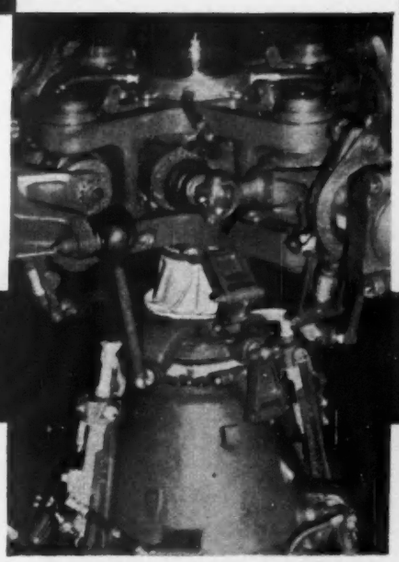

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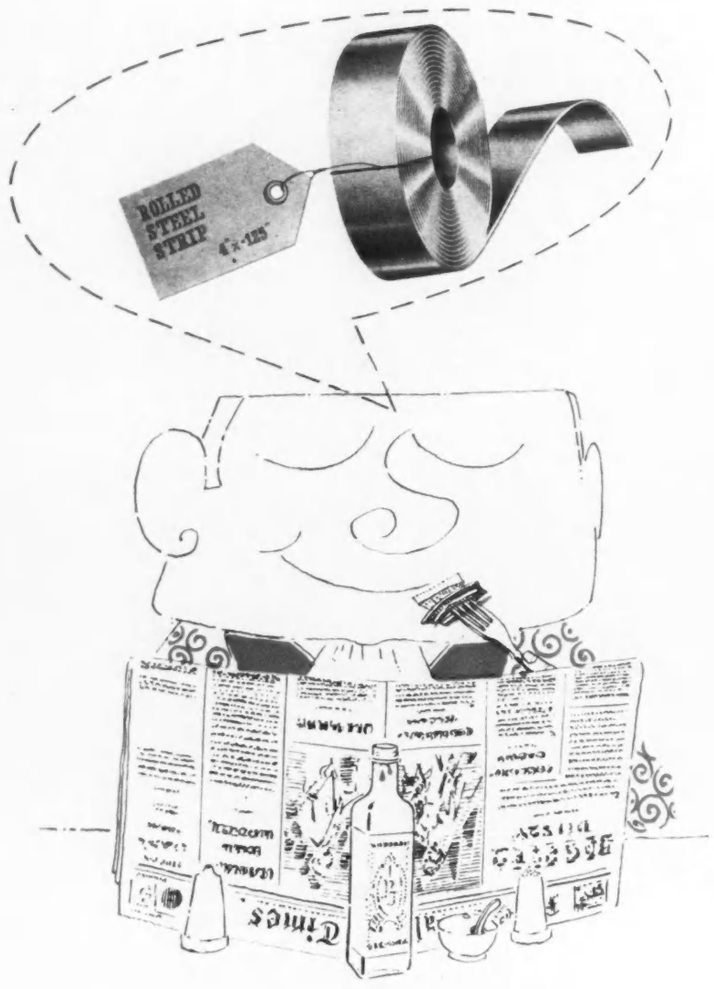

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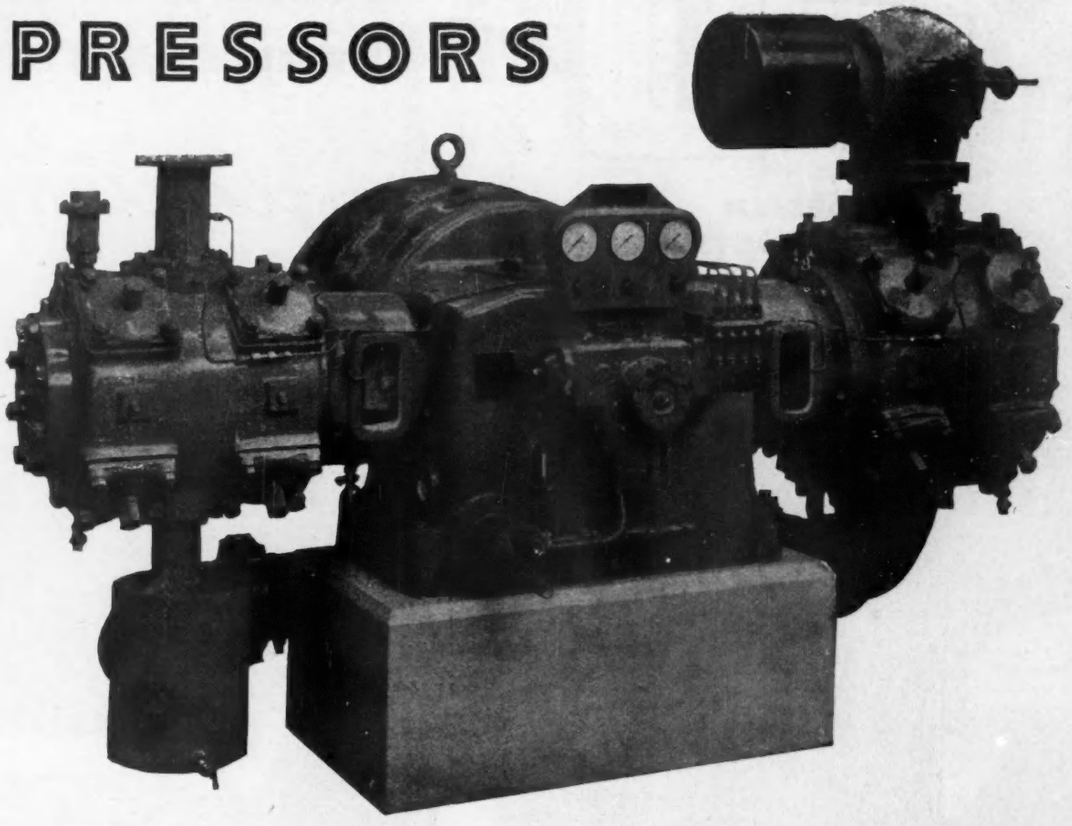

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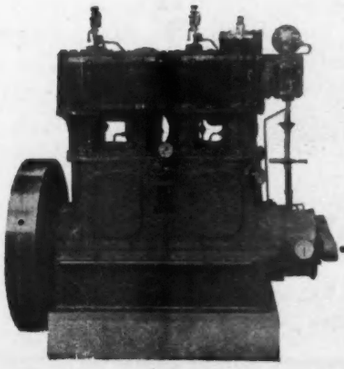

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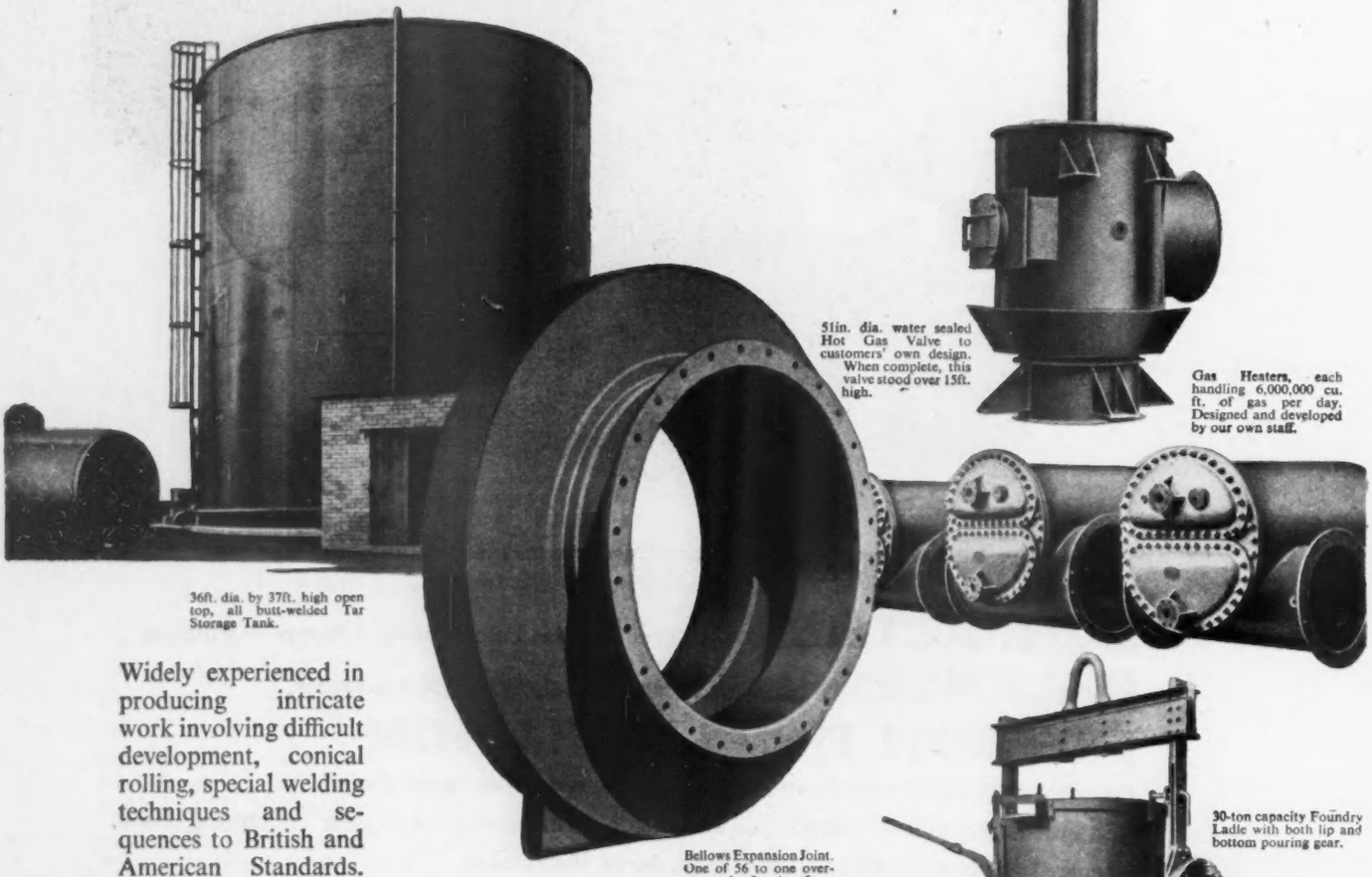

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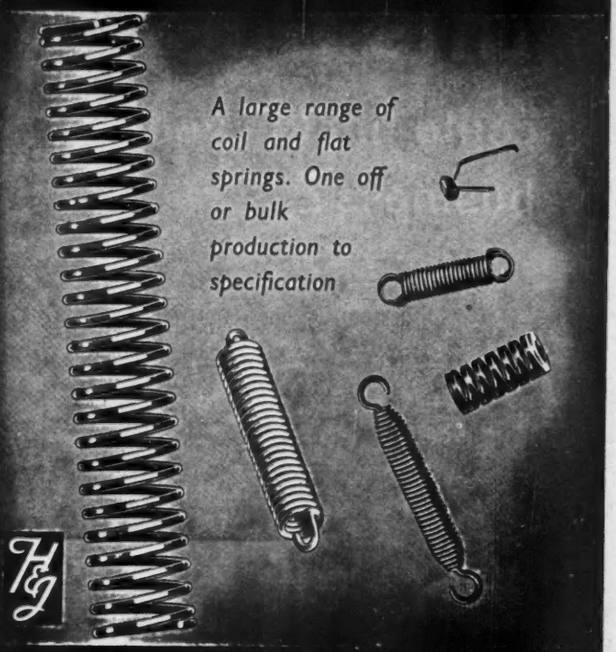

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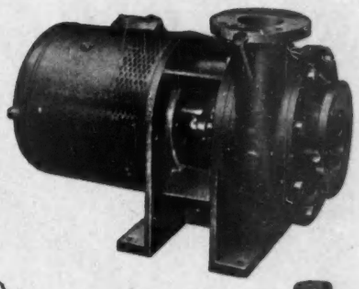

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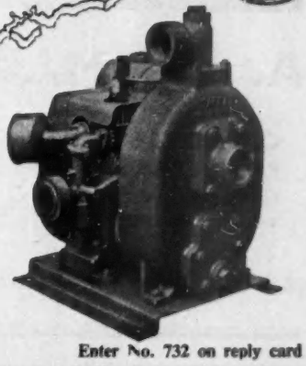

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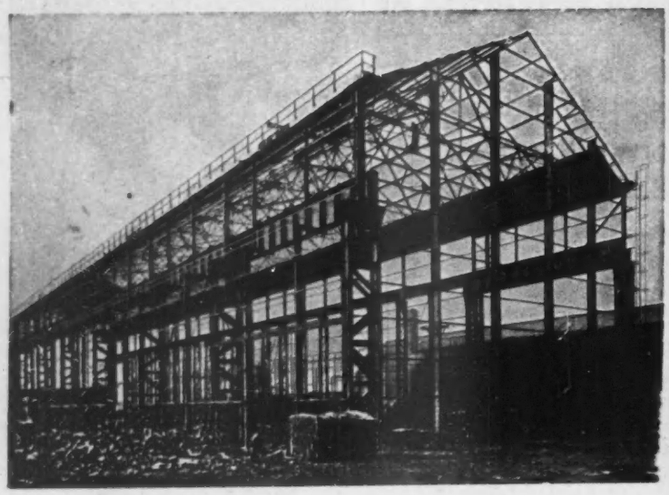

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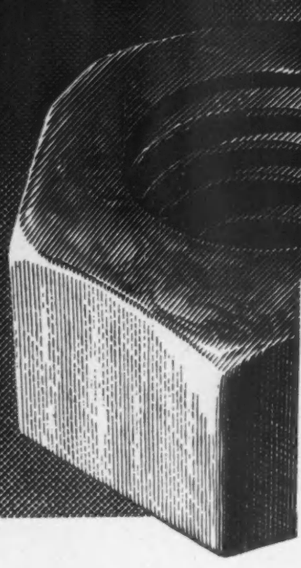

A steam loco-type crane runs on a track. If the track is faulty—if, for example, a nut is loose on a fish-plate, chair, or sprag, a travelling crane may wobble, tilt, and topple, to end up overturned. The cost of such a mishap is impossible to predict: while it may be measured in time lost, profits lost, it could also very possibly spell a life lost.

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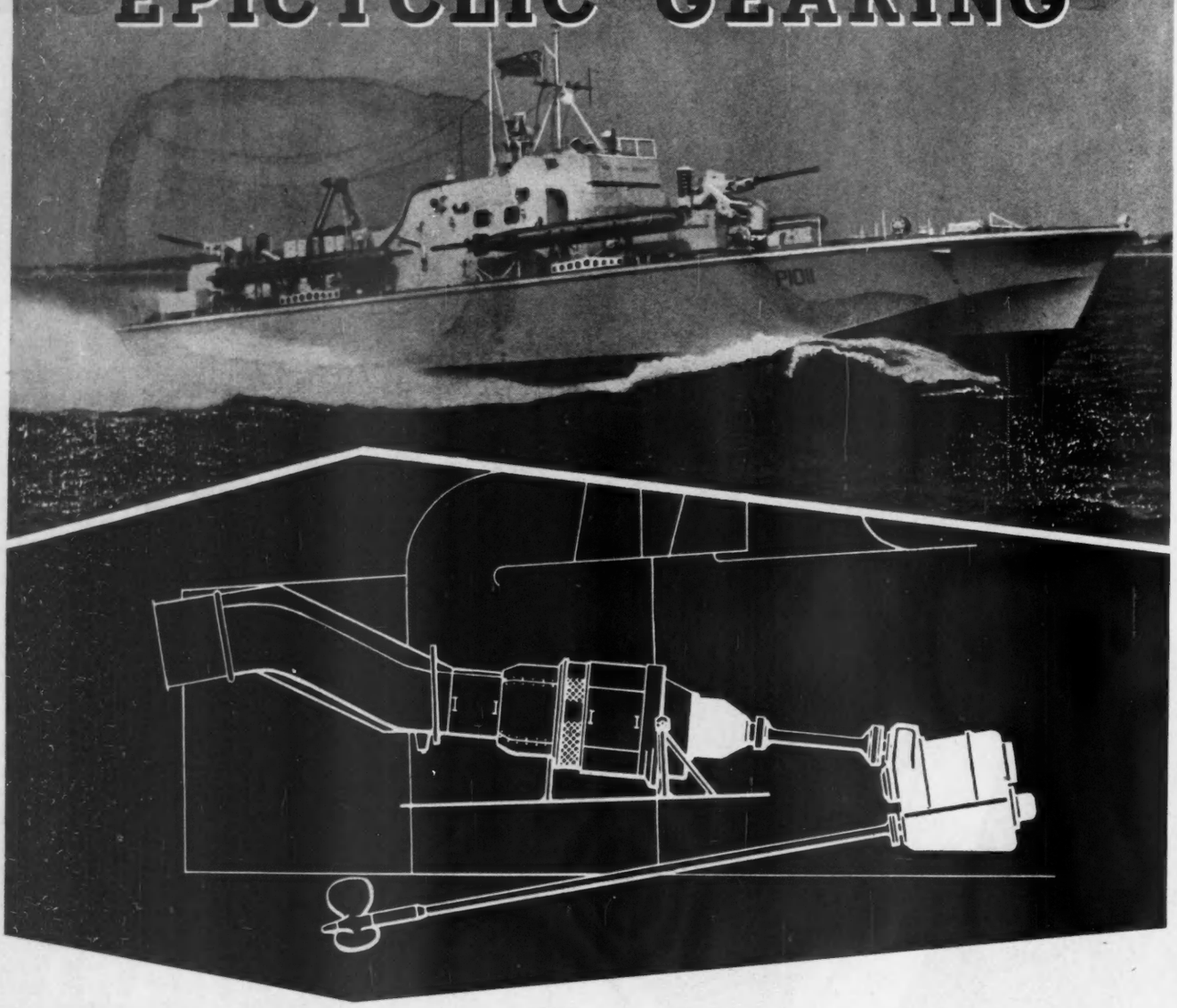

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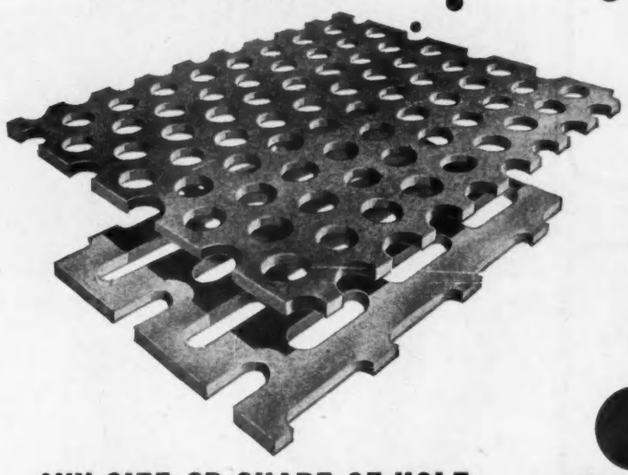

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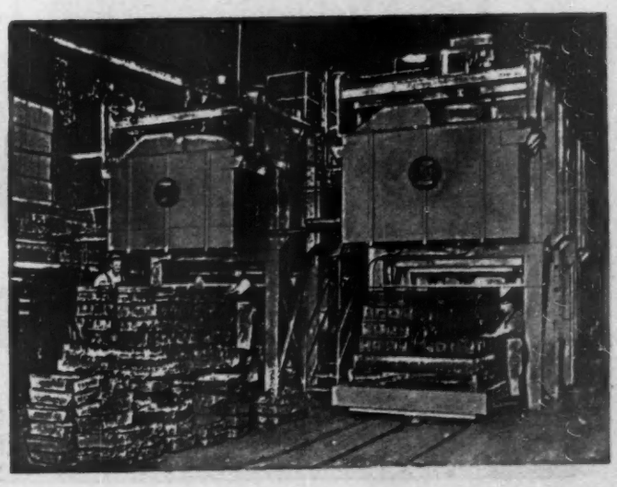

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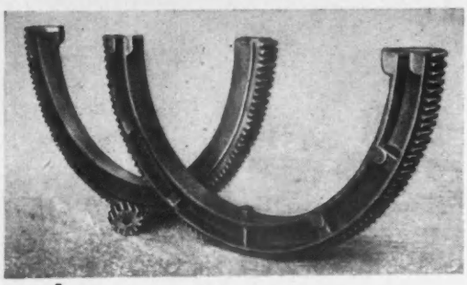

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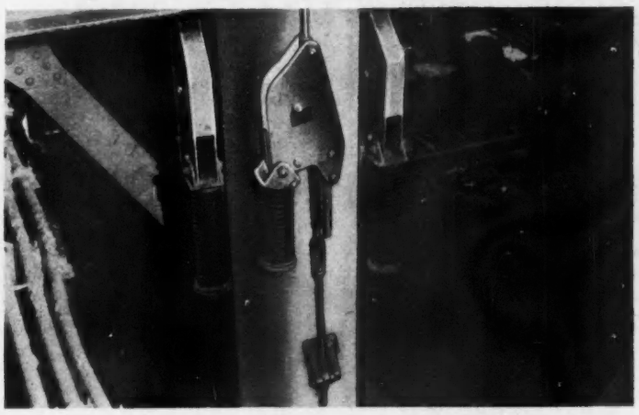

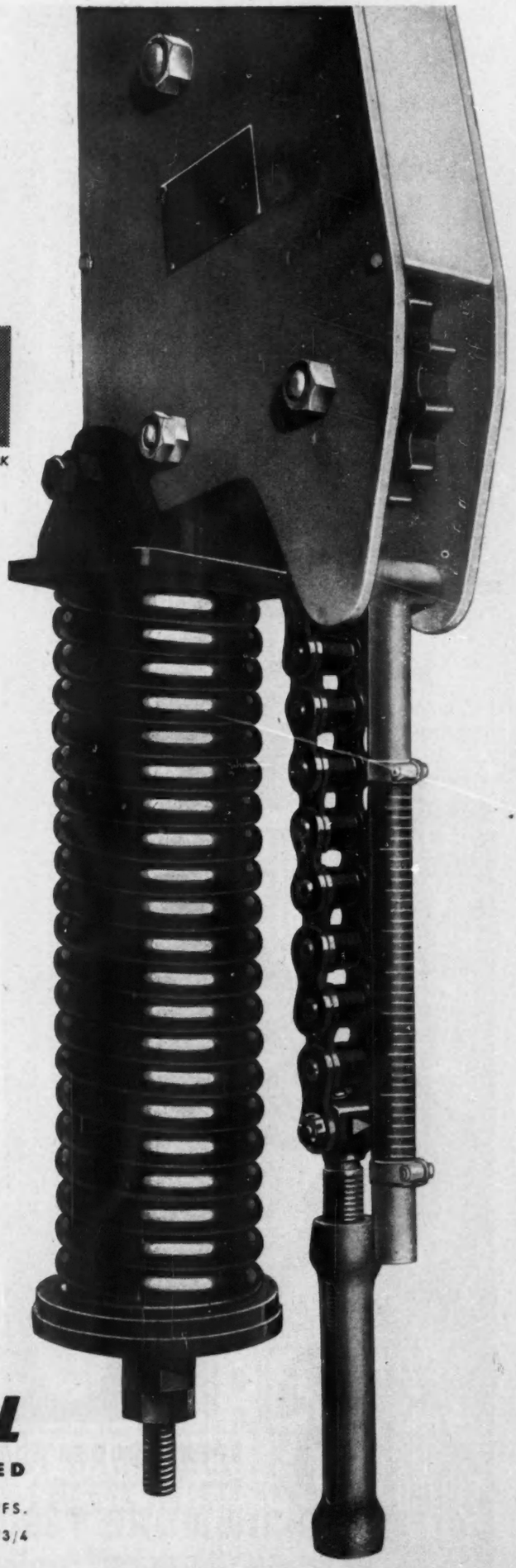

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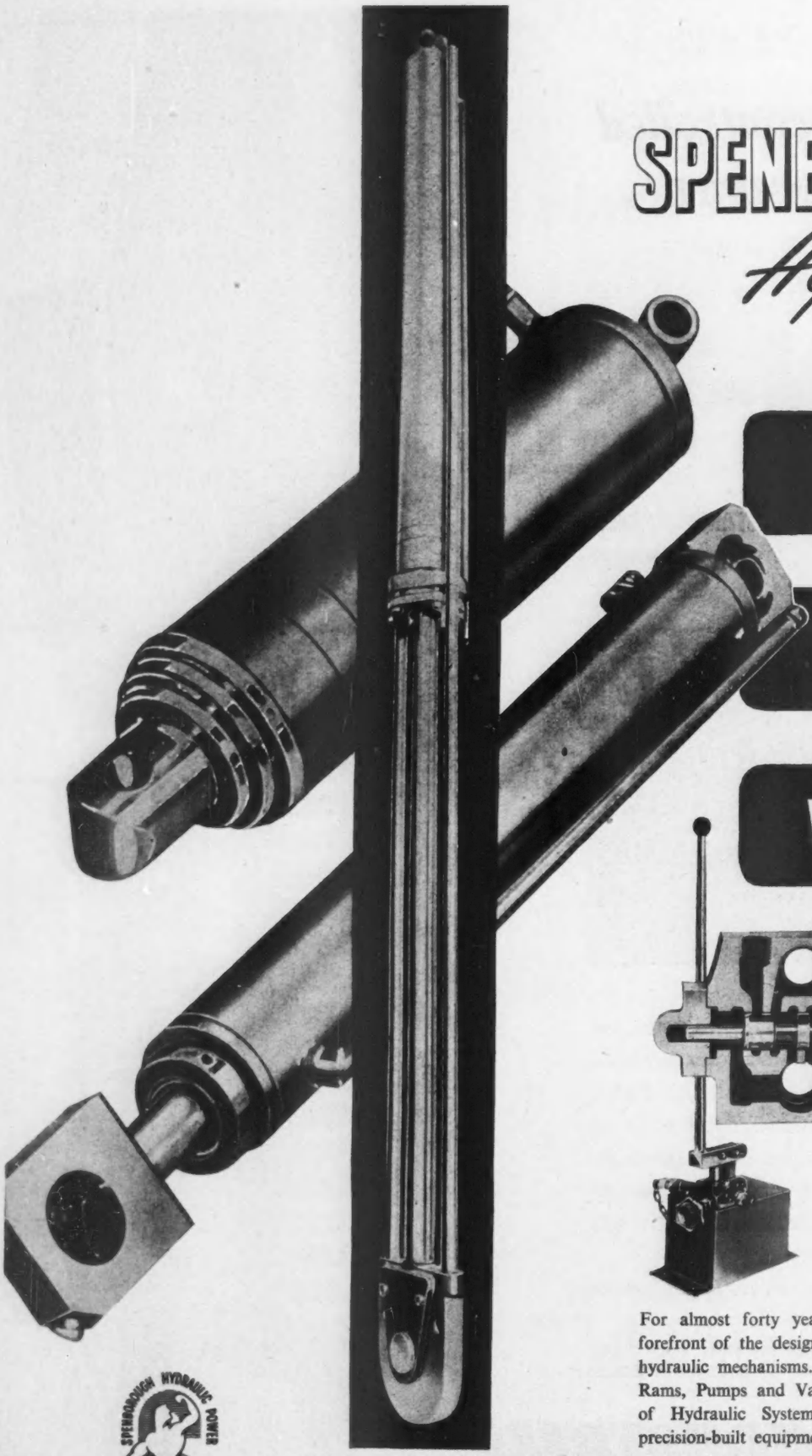

RAMS

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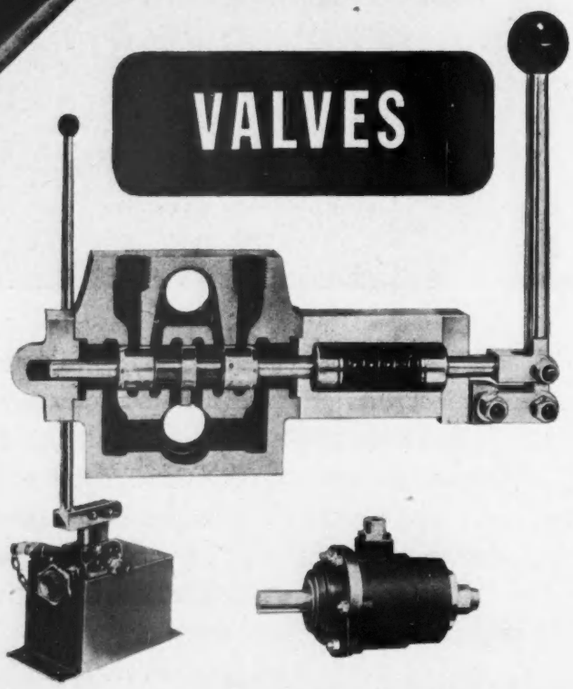

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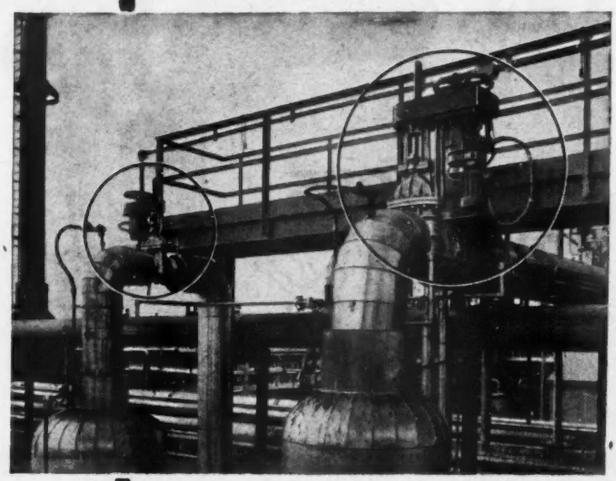

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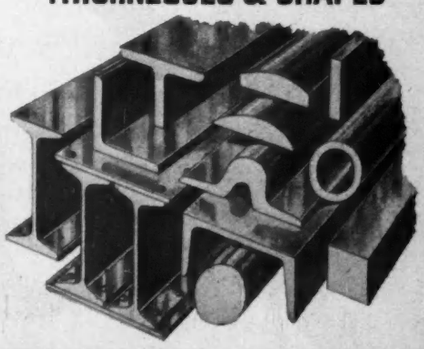

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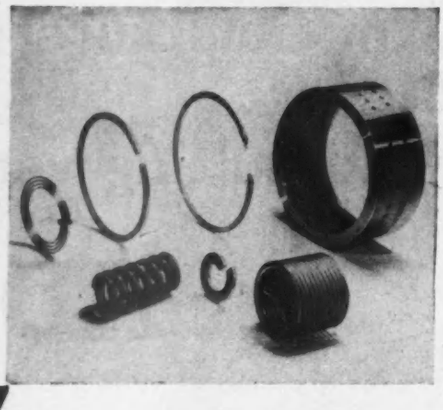

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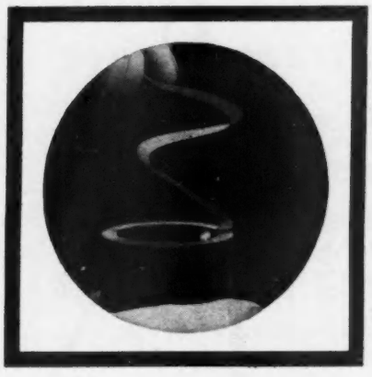

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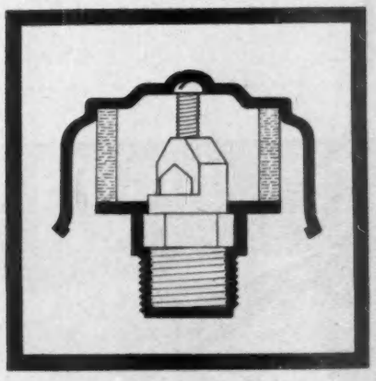

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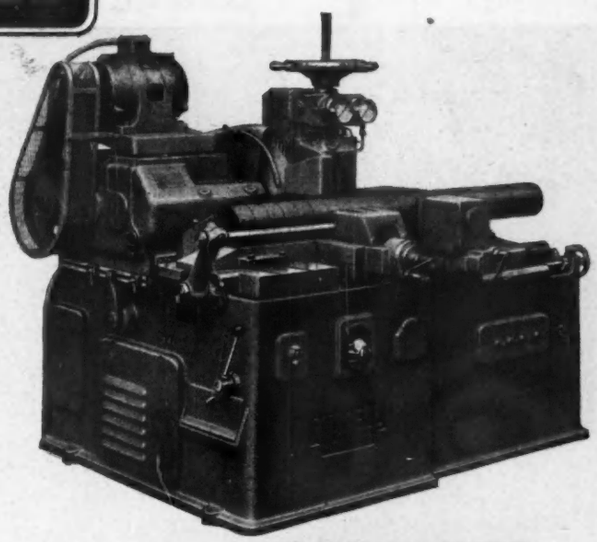

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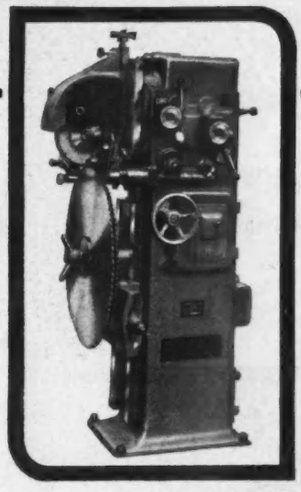

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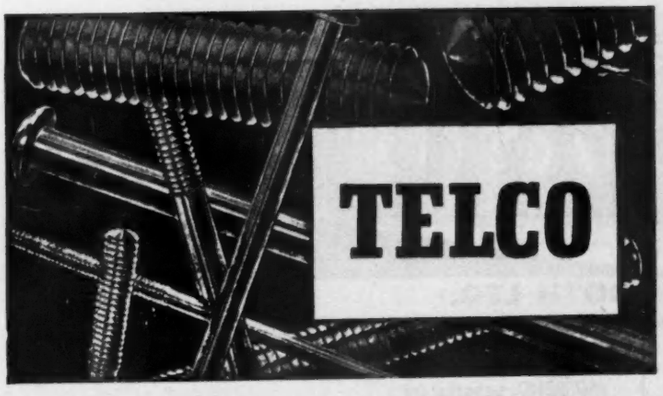

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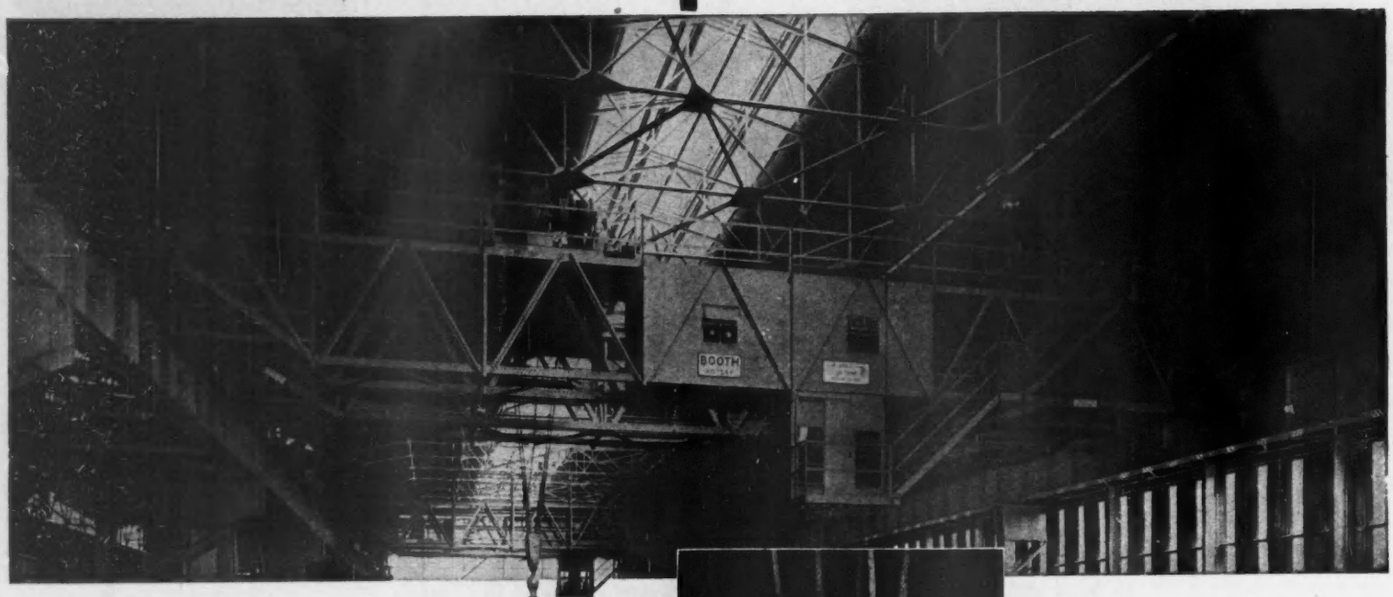
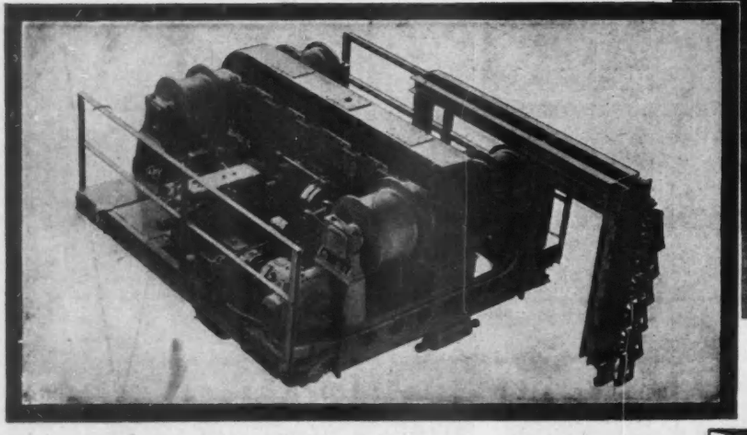


(ABOVE) Clyde-Booth four point suspension electric overhead travelling magnet crane at Messrs. Colvilles Ltd., Ravenscraig Works.

(RIGHT) The hook with slip-ring gear for the magnet, showing attachment of the four ropes.

(BELOW) The special four barrel crab.



With the introduction of higher rates of acceleraton and braking on traversing and long travel motions, in order to get the maximum output from overhead travelling cranes, magnet cranes with multiple splayed ropes are finding favour.

This type of suspension effectively damps out swinging of the load due to acceleration and braking forces.

Clyde-Booth cranes of three and four rope suspension design are produced to meet these requirements.

Our publication "The Booth Handbook on Overhead Cranes" is available on request.

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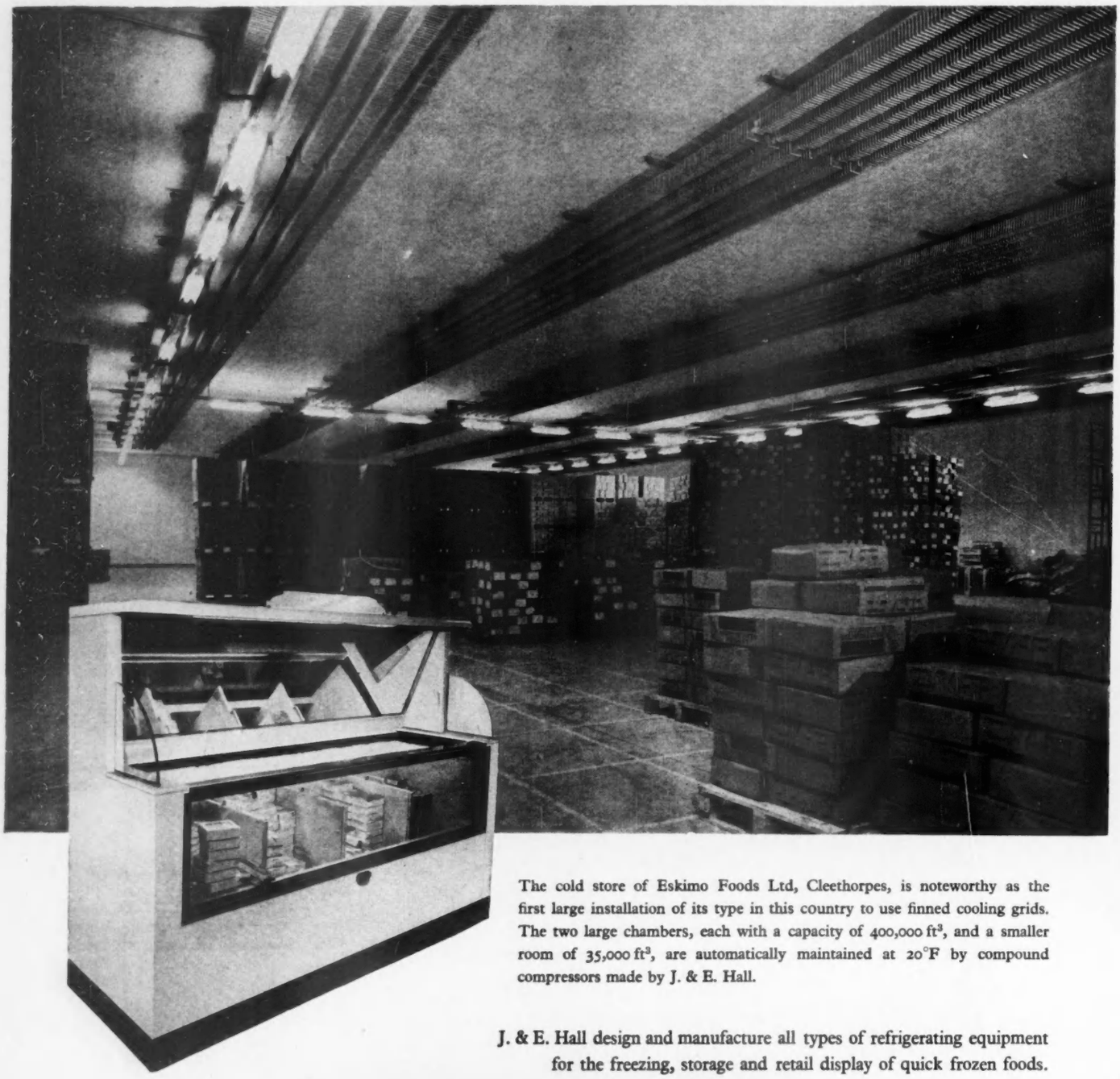

The cold store of Eskimo Foods Ltd, Cleethorpes, is noteworthy as the first large installation of its type in this country to use finned cooling grids. The two large chambers, each with a capacity of 400,000 ft³, and a smaller room of 35,000 ft³, are automatically maintained at 20°F by compound compressors made by J. & E. Hall.

J. & E. Hall design and manufacture all types of refrigerating equipment for the freezing, storage and retail display of quick frozen foods.

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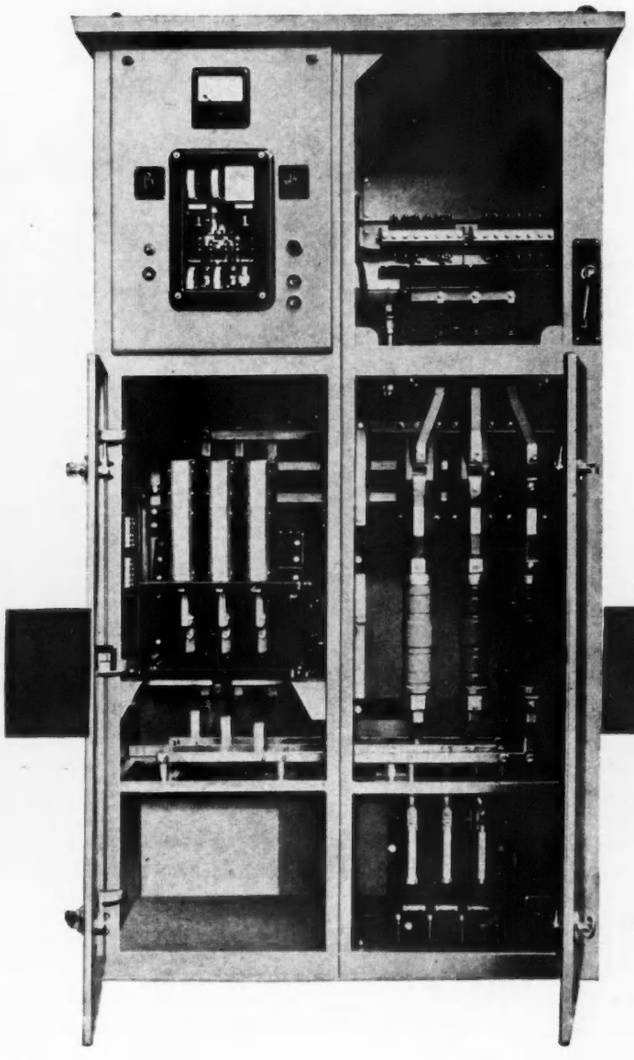
THE BELMOS 3·3kV AIR-BREAK CONTACTOR STARTER



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the type K starter is fully described and illustrated in leaflet J 240 which is available on request.

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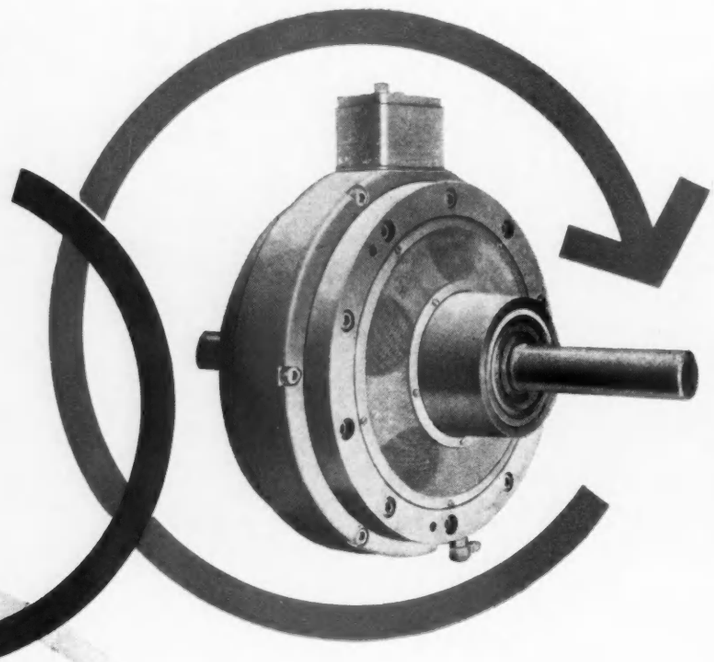

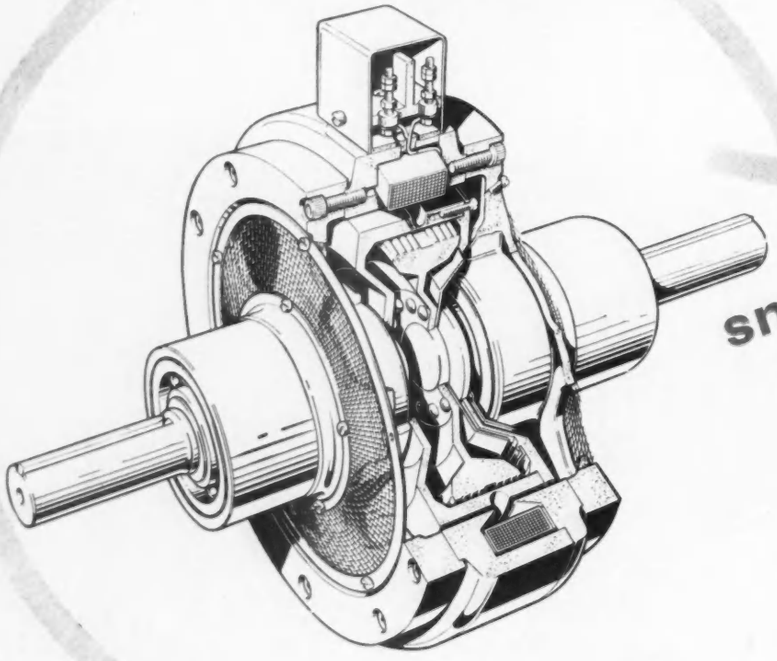

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If your requirements include coupling units with torque capacities between 1/3 and 200 lb/ft, let us advise you on the application of these units in your plant.

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FOR KINGS COLLEGE UNIVERSITY OF DURHAM

A typical custom-built control panel designed to the specification of R. W. Gregory & Partners, Consulting Engineers of Newcastle-on-Tyne, for the new Physics Teaching Block of Kings College, University of Durham.

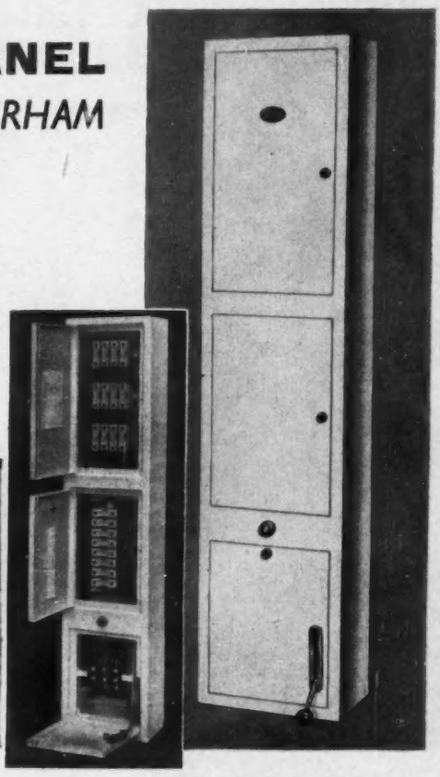
This is one of a number at present being made up in our Panels Department, which is fully equipped to manufacture custom-built switchboards, control units and motor control cubicles, etc.

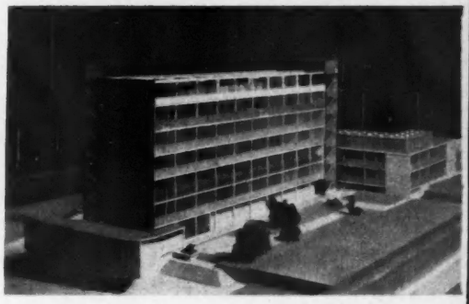
The unit illustrated incorporates the new "EXEL" distribution board interiors which are suitable for either rewirable or H.R.C. fusing, and in the case of H.R.C. types, the fuse carriers will accommodate H.R.C. cartridge fuses to B.S. 88, 1952, Clause J. dimensions.

The main fused isolator is of the well known "Glasgow-Rex" range modified for flush mounting and rated at 60 amps, 500 volts, T.P. & N. pattern.

Fusing of the distribution section is 30 amp throughout.

Architects—Basil Spence & Partners



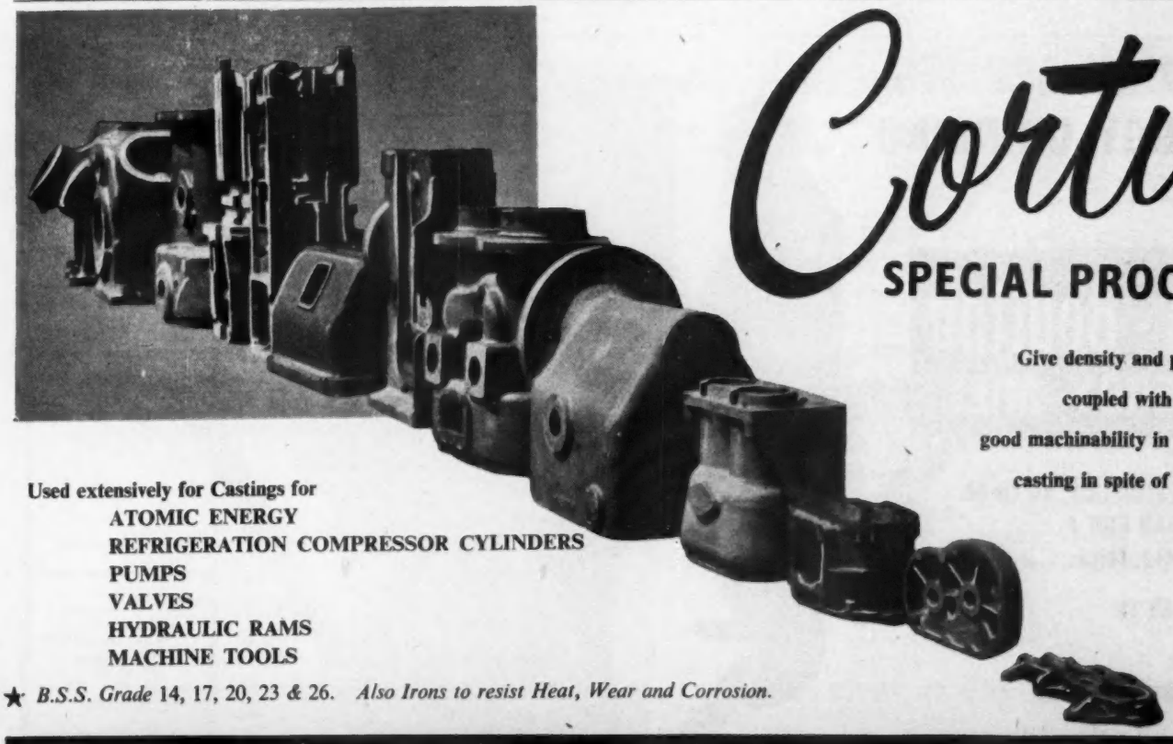


The cabinet is of dust proof construction. The covers, which are flush pattern, are mounted on concealed hinges and are fitted with gaskets of resilient foam rubber.

MEM

MIDLAND ELECTRIC MANUFACTURING CO. LTD. REDDINGS LANE, TYSELEY, BIRMINGHAM, 11

Enter No. 911 on reply card



Cortite
SPECIAL PROCESS IRONS

Give density and pressure tightness, coupled with high strength and good machinability in all sections of the casting in spite of extreme variation of thickness.

Used extensively for Castings for

ATOMIC ENERGY
REFRIGERATION COMPRESSOR CYLINDERS
PUMPS
VALVES
HYDRAULIC RAMS
MACHINE TOOLS

★ *B.S.S. Grade* 14, 17, 20, 23 & 26. *Also Irons to resist Heat, Wear and Corrosion.*

ROBERT CORT & SON LTD

READING Tel: READING 55046 (5 lines) Grams: CORTS READING BERKS.

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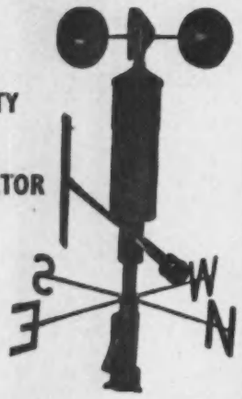
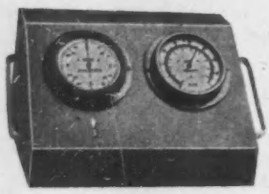
WIND DIRECTION ← INDICATOR →

for mains operation combined with

WIND VELOCITY CUP GENERATOR



NO brushes or rubbing contacts



Velocity & direction dials or recorders can be supplied

R. W. MUNRO LTD.

BOUNDS GREEN, LONDON, N.11

Makers of Anemometers for eighty years

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OIL SIGHTS FOR MACHINE TOOLS

Accuracy to finest limits is automatically expected of every Rotherham product. The type of Oil Sight for Machine Tools illustrated serves to strengthen this confidence in Rotherham quality. This pattern is threaded $\frac{1}{4}$" B.S.P. Other sizes may be quoted for in production quantities. Remember us also for brass T, Y, 4-Way and Elbow Pieces, Brass Taps of all kinds, Brass Grease Cups, Winkley Oilers, etc.

Rotherhams OF COVENTRY

ROTHERHAM & SONS LTD.
COVENTRY. *Tele: 64154*
PRECISION MANUFACTURERS SINCE 1750

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THE SKERNE WORKS LIMITED

ALBERT HILL, DARLINGTON

Tel: DARLINGTON 5612

•

PRESSINGS
PRESSED SECTIONS
COLD FORMED SECTIONS
FABRICATIONS
MACHINED PARTS

IN ALL METALS

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All enquiries promptly dealt with

Enter No. 923 on reply card

SUCCESSFULLY APPLIED VIBRO-ENERGY GRINDING BY

Podmore - Boulton
VIBRO-ENERGY MILL

- **FINE GRINDING EFFICIENCY, 10 TO 30 TIMES HIGHER THAN FOR A CONVENTIONAL BALL MILL.**
- **SMOOTH AND QUIET IN OPERATION.**
- **LESS CONTAMINATION OF END PRODUCT.**
- **SAMPLING DURING OPERATION.**

Some other machines manufactured by William Boulton

WILLIAM BOULTON LIMITED

PROVIDENCE ENGINEERING WORKS, BURSLEM, STOKE-ON-TRENT

PHONE: STOKE-ON-TRENT 88661 (5 LINES) **GRAMS: BOULTON, BURSLEM**

WB 50

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'Arcon' 75 foot span transit building supplied by Taylor Woodrow (Arcon) Ltd., for Dover Harbour Board, Dover, Kent, in which Clear Corrugated 'Perspex' sheet, type 568, has been used for the roof lighting. Consultants: Coode & Partners.

Corrugated 'Perspex' for efficient roof lighting throughout the world

'Arcon' 66 ft. 8 in. span factory building supplied by Taylor Woodrow (Arcon) Ltd., for Bush Radio Limited, Plymouth, in which Clear Corrugated 'Perspex' sheet, type 568 has been used for the roof lighting. Architects: Fuller, Hall & Foulsham.

TAYLOR WOODROW (ARCON) LTD., supplied these buildings for the Dover Harbour Board and Bush Radio Limited; in both, the consultants specified Corrugated ' Perspex ' for the roof lighting.

Corrugated ' Perspex ' is inexpensive to instal[1]. It saves money on artificial lighting, and lasts indefinitely. It is tough, yet light and easy to handle. Corrugated ' Perspex ' is unaffected by the severest weather and withstands the corrosive atmospheres of industrial and marine areas.

Corrugated ' Perspex ' is available in a wide range of profiles to fit most corrugated roofing materials. If diffused daylight is desired, Opal Corrugated ' Perspex ' is available.

It's as clear as daylight—it must be

CORRUGATED 'PERSPEX'

'Perspex' is the registered trade mark for the acrylic sheet made by I.C.I.

IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

CP.167

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you'll rest content if you leave it to * WARNE WRIGHT

Not only are they determined to ensure your complete satisfaction but they are proud of their high standards of quality and precision and their fine reputation for Service that has won world-wide acclaim. Call in the Warne-Wright man. He'll be pleased to tell you more about the specialist technicians always available to help you with your special problems. And of the many Warne-Wright stock lines — such as drop forgings, precision-turned parts and presswork, spanners, wrenches, high tensile bolts and nuts, black and bright, too. Just leave it all to Warne-Wright.

* **WARNE, WRIGHT AND ROWLAND LTD**

Keeley Street, Birmingham 9

Beardmore

Enter No. 941 on reply card

CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/- **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.
There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/- **Inch Rate.** 48/- per single column inch and pro rata. 12 lines to 1 inch.
There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

***Advertisements for publication should be addressed to :*—Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

CITY OF BIRMINGHAM EDUCATION COMMITTEE

HALL GREEN TECHNICAL COLLEGE, STRATFORD ROAD, BIRMINGHAM, 28

Principal-Designate : G. H. PALMER, M.Sc., A.Inst.P.

HEAD OF THE ENGINEERING DEPARTMENT

Applications are invited for the post of HEAD OF THE ENGINEERING DEPARTMENT (Grade II), to take up duties on 1st September, 1960.

The College is now being built and will open in September, 1960. The Department will be mainly concerned with Mechanical Engineering Courses to Ordinary National Certificate standard, Machine Shop Engineering and similar courses, and Motor Vehicle work for which the College is specially equipped. There will be Electrical Installation and possibly other Electrical Courses.

Applicants should be Graduates, preferably in Mechanical Engineering, with good teaching and industrial experience. It is hoped to appoint a man with energy and initiative to develop the work of the new Department.

Salary : (Burnham Report, 1959) : £1600 by £50 to £1800 per annum.

In certain circumstances it may be possible to offer a starting salary above the minimum of this scale. Application forms and further particulars of the post may be obtained from the Principal-Designate, present address : Matthew Boulton Technical College, Suffolk Street, Birmingham, 1. Completed forms should be returned to him not later than 15th February.

E. L. RUSSELL.
E8623 Chief Education Officer.

CITY OF LIVERPOOL EDUCATION COMMITTEE

CITY COLLEGE OF TECHNOLOGY, BYROM STREET, LIVERPOOL, 3

Principal : S. A. J. PARSONS, B.Sc. (Econ.), M.I.Mech.E., M.I.Prod.E., M.B.I.M.

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

The Governing Body invites applications from suitably qualified persons for the appointment of LECTURER IN MECHANICAL ENGINEERING (full-time). Duties to commence as soon as possible.

Salary : £1370 by £35 to £1550 per annum (Burnham Technical Report). (Increments within the scale may be added to the commencing salary for approved industrial or professional experience or research work of an equivalent standard.)

Applicants should have a good University Degree and preferably a professional qualification, together with appropriate industrial and/or research experience. They should be able to offer Mechanical Engineering Subjects and should be prepared to teach up to Graduate level. Members of staff are encouraged to undertake research, under guidance.

Further particulars and application form (returnable by 6th February, 1960) from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
(J.6002) Town Clerk and Clerk to the
E8627 Local Education Authority.

LONDON COUNTY COUNCIL

ROBERT BLAIR FELLOWSHIP IN APPLIED SCIENCE AND TECHNOLOGY

Applications are invited for the award of the Robert Blair Fellowship tenable for one year of advanced study or research abroad in applied science and technology. The value of the award is subject to variation, and, if the country selected should be Canada or the U.S.A., may be up to £2,000 (subject to income tax).

Candidates must be British subjects and at least 21 years of age.

Further particulars and forms of application may be obtained from the Education Officer (ED/WA/14), The County Hall, S.E.1 (stamped, addressed foolscap envelope necessary) for return by 12 March, 1960. (79). E8580

PUBLIC APPOINTMENTS

UNIVERSITY OF SHEFFIELD

POSTGRADUATE DEPARTMENT OF APPLIED MECHANICS

RESEARCH ASSISTANT

Applications are invited for a post of RESEARCH ASSISTANT in the Postgraduate Department of Applied Mechanics to begin duties as soon as possible. Salary in the range £650–£750 according to qualifications and experience, and F.S.S.U. provision and family allowance. A grant towards removal expenses will be made. Further particulars may be obtained from the Registrar to whom applications (4 copies) should be sent by 13th February, 1960. E3555

CITY OF CARDIFF EDUCATION COMMITTEE

LLANDAFF TECHNICAL COLLEGE

Principal : J. COTTERELL, M.I.E.E., A.I.Mech.E., A.M.I.Prod.E.

ASSISTANT LECTURERS

GRADE "B" ASSISTANT LECTURER IN PRODUCTION ENGINEERING.

To teach Production Engineering, both theoretical and practical subjects, to City and Guilds and Ordinary National Certificate standards.

Candidates should hold either a Higher National Certificate in Mechanical or Production Engineering or Final City and Guilds in Machine Shop Engineering, and have had sound industrial experience. Teaching experience is desirable.

A Special Responsibility Allowance of £100 per annum may be awarded to a suitably qualified applicant for organising and development duties within the Engineering Department.

GRADE "B" ASSISTANT LECTURER IN RADIO AND TELEVISION SERVICE WORK.

To teach Radio and Television Servicing to Final City and Guilds standard. Applicants should be capable of giving both theoretical tuition and practical instruction in the subjects mentioned.

Candidates should have one or more of the following qualifications : B.Sc. (Engineering), A.M. Brit.I.R.E., Final City and Guilds in Radio and Television Servicing or a Higher National Certificate in Electrical Engineering with an Electronic or Radio subject. Sound practical experience is essential and teaching experience is desirable.

Salary : Grade "B", £700 by £27 10s. to £1150, plus allowances for training, degree, &c.

Application Forms and further particulars may be obtained from the undersigned.

ROBERT E. PRESSWOOD,
City Hall, Director of Education.
Cardiff. E8593

WORCESTERSHIRE EDUCATION COMMITTEE

COLLEGE OF FURTHER EDUCATION, BROMSGROVE

ENGINEERING DEPARTMENT

ASSISTANTS

Applications are invited from suitably qualified persons for the following full-time appointments which are currently vacant.

Assistant, Grade "B" to teach mechanical engineering subjects in Ordinary National Certificate courses—there will be an opportunity to do more advanced work if desired.

Assistant, Grade "B" to teach machine shop engineering subjects, to include Workshop Technology, Calculations and Science and Workshop Drawing up to Final City and Guilds level in Machine Shop Engineering.

Assistant, Grade "A" to teach Machine Shop Practice up to C. & G. Intermediate Machine Shop Engineering level—a sound practical background is essential for this post.

For all the above posts, teaching experience, though an advantage, is not essential. Salaries will be in accordance with the revised Burnham Technical Scales.

Assistant, Grade "B" : £700 by £27 10s. (15) and £37 10s. to £1150 per annum.

Assistant, Grade "A" : £520 by £27 10s. (16) and £40 to £1000 per annum.

plus graduate and training allowances, with increments for approved professional and/or industrial experience.

Application forms may be obtained from the County Education Officer (TS), County Education Office, Castle Street, Worcester, on receipt of a stamped, addressed foolscape envelope (V.97). E8582

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF BRIGHTON EDUCATION COMMITTEE

BRIGHTON TECHNICAL COLLEGE

ASSISTANT LECTURER

Required as soon as possible :

ASSISTANT LECTURER (Grade B) in MECHANICAL ENGINEERING. Degree in Engineering, A.M.I.Mech.E., or equivalent essential. Teaching experience is desirable.

Salary scale : £700 by £27 10s. (15) plus £37 10s. to £1150 (men), plus graduate and training allowances, and with increments for approved research, professional or industrial experience.

Further particulars and forms of application from the undersigned, to be returned to the Principal, Brighton Technical College, Brighton, 7, within 14 days.

W. G. STONE,
Director of Education.
54, Old Steine,
Brighton. E8602

ROYAL AIRCRAFT ESTABLISHMENT, TECHNICAL COLLEGE, FARNBOROUGH, HANTS.

SENIOR LECTURER IN AIRCRAFT STRUCTURES

Applications invited for post of SENIOR LECTURER IN AIRCRAFT STRUCTURES, to teach subject for Final B.Sc. (Eng.), Dip. Tech. and A.F.R.Ae.S.

University Degree, or equivalent, and preferably some industrial and/or teaching experience required. Facilities for research available. Duties to commence as soon as possible.

Burnham Scale for Technical Colleges : £1550 by £50 to £1750.

Details and application forms from Principal of College, for return within fourteen days. E8621

BECHUANALAND PROTECTORATE

PUBLIC WORKS DEPARTMENT

ENGINEER (MECHANICAL)

To assist the Senior Engineer (Mechanical) in the running of the Government Workshops, transport and mechanical equipment.

Permanent or contract/gratuity appointment. Salary in range £928–£1848. Rented quarters. Free passages. Children's education allowance.

Candidates must be A.M.I.Mech.E. or possess B.Sc. in Mechanical Engineering with at least 5 years' relevant experience.

Write Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD 112/76/013/D4. E8603

BRITISH RAILWAYS

LONDON MIDLAND REGION

STRUCTURAL ENGINEER

British Railways, London Midland Region, require a STRUCTURAL ENGINEER at Euston to undertake design in steel, reinforced and prestressed concrete, capable of calculating statically indeterminate structures. Must have a University degree and experience in similar work. Post Graduate studies and membership of the Institution of Civil Engineers or the Institution of Structural Engineers will be an advantage.

Salary range £1150 to £1315 per annum. Superannuation Scheme, five-day week, residential and other travelling facilities.

Applications quoting reference 90 and giving details of age, educational qualifications and experience to : Chief Civil Engineer, British Railways, London Midland Region, 5a, Euston Grove, London, N.W.1. E8565

PUBLIC APPOINTMENTS

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS required in following localities :

LONDON AREA : MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics, to carry out research programme in particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for research on precision gear design. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles ; knowledge of theoretical hydrodynamics and theory of control mechanisms an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICIST for acoustic analysis. APPLIED MATHEMATICIAN for work with electronic computers, with special reference to research into general underwater physical problems. ELECTRONIC PHYSICISTS for data handling and analysis problems. EXPERIMENTAL PHYSICIST for research in underwater acoustics. PHYSICIST interested in operation performance. CLASSICAL PHYSICISTS.

BALDOCK : PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH : PHYSICISTS with experience in field of microwave techniques. ELECTRONIC/ELECTRO-MECHANICAL ENGINEERS (experience in servo-mechanisms an advantage).

HASLEMERE : ELECTRONIC ENGINEER.

PORTLAND : PHYSICISTS or APPLIED MATHEMATICIANS for research in underwater acoustics. PHYSICISTS (general). ELECTRICAL ENGINEERS with advanced electronic design experience. MECHANICAL ENGINEERS. PHYSICAL CHEMISTS.

POOLE : CHEMICAL ENGINEERS. CHEMISTS with experience in rubber technology.

ROSYTH : MECHANICAL ENGINEER with experience in welding development. ELECTRONIC PHYSICISTS.

Candidates must normally be natural born British subjects of natural born British parents, with First or Second-Class Hons. Degrees or equivalent qualifications. S.S.O.s must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men) : S.S.O., £1233–£1460 ; S.O., £655–£1150 (London), somewhat lower in provinces.

Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those under 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.483/9A). E7844

CITY OF SHEFFIELD

CITY ENGINEER AND SURVEYOR'S DEPARTMENT

CHIEF HIGHWAYS ASSISTANT, GRADE B

Appointment of CHIEF HIGHWAYS ASSISTANT, Grade B (£1315–£1530 per annum).

Applications are invited from suitably qualified and well-experienced Civil Engineers for the above appointment on the permanent staff of the City Engineer and Surveyor and Town Planning Officer (H. Foster, M.A., M.I.C.E., M.I.Mun.E.).

Applicants must be Chartered Civil and/or Municipal Engineers with considerable experience in the design and construction of roads in congested urban areas. The duties will include control and supervision of the staff of the highways design section and staff management experience is therefore essential.

Superannuable post, N.J.C. conditions of service, medical examination.

Applications, stating age, education and training, experience, qualifications, present and past appointments (with dates and salaries), and quoting the names of two referees, to be submitted to the undersigned by the 8th of February, 1960.

JOHN HEYS,
E8620 Town Clerk.

Classified Advts. continued on page 96

PUBLIC APPOINTMENTS

NEW ZEALAND MINISTRY OF WORKS

ENGINEERING STAFF

The New Zealand Ministry of Works invites applications for the following vacancies on the Permanent Staff. Positions, qualifications desired, and salaries offered, are as follows :

Vacancy No. 1.—CIVIL ENGINEERS

Corporate Membership of the Institution of Civil Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1525 per annum.

Vacancy No. 2.—ASSISTANT CIVIL ENGINEERS

A University Degree in Civil Engineering, or Graduate Membership of the Institution of Civil Engineers, London, with at least five years of practical experience since commencement of pupilage. Commencing salaries : £870 up to £1060 per annum.

Vacancy No. 3.—MECHANICAL or ELECTRICAL ENGINEERS.

Corporate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1525 per annum.

Vacancy No. 4.—BUILDING SERVICES ENGINEERS

Corporate Membership of the Institution of Heating and Ventilating Engineers, London. Commencing salaries up to £1450 per annum.

Vacancy No. 5.—ASSISTANT MECHANICAL or ELECTRICAL ENGINEERS

A University Degree in Mechanical Engineering or Graduate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with at least five years' experience since commencement of pupilage. Commencing salaries : £870 up to £1060 per annum.

Vacancy No. 6.—ASSISTANT BUILDING SERVICES ENGINEERS

Graduate Membership of the Institution of Heating and Ventilating Engineers, London, with at least five years' experience since commencement of pupilage. Commencing salaries : £870 to £1060 per annum.

Civil Engineers and Assistant Engineers must have had experience in the design or construction of multi-storied reinforced concrete buildings or bridges and other structures. For the other vacancies experience is necessary in the design and installation of services or equipment for one or more of the following : heating and ventilating, air conditioning, hot and cold water or sewerage services, laundries, kitchens, boiler-houses, lifts and other mechanical services in offices, schools, hospitals, hotels, telephone exchanges, printing works, defence establishments, &c. All appointees will be required to undertake work of this nature.

APPLICANTS MUST BE RESIDENT IN THE UNITED KINGDOM OR EIRE AND HAVE FULFILLED NATIONAL SERVICE OBLIGATIONS.

Enquiries, mentioning this publication and stating the Vacancy Number and the position sought, should be addressed to the High Commissioner for New Zealand, 415, Strand, London, W.C.2. Full details of duties, experience required, general information on the conditions of employment in the New Zealand Public Service, and application forms, will then be supplied. E8411

REPUBLIC OF THE SUDAN

MINISTRY OF WORKS

MECHANICAL ENGINEER

Applications are invited from those suitably qualified to fill a vacancy of MECHANICAL ENGINEER (Road Plant) in the Ministry of Works, Sudan.

Candidates should be Corporate Members of the Institution of Mechanical Engineers or hold an equivalent qualification, have sound knowledge of, and at least five years' experience in the management of modern road equipment.

The selected candidate will be responsible for the maintenance, repair and general management of road plant throughout the Sudan. He may also be required to train Sudanese Staff.

Age 30–45 years. Candidates outside this grouping may also be considered.

Appointment will be made on contract for a period of three years in the salary range £S.1146–£S.1786. The point of entry will be determined by age, qualifications, and experience.

A cost-of-living allowance is payable and an initial outfit grant of £S.50 will be paid upon appointment.

Annual U.K. leave accrues at the rate of seven days per month with free air passage.

Applications, quoting fullest particulars of qualifications, experience and age should be sent to the Sudan Embassy, Appointments Section, Cleveland Row, St. James's, London, S.W.1, quoting reference 4/1824.

Closing date 15th February, 1960. E8564

BRITISH WATERWAYS

WATFORD

ASSISTANT ENGINEER

British Waterways require ASSISTANT ENGINEER at Watford. Must be A.M.I.C.E. with experience in design and construction of Civil Engineering Works by contract and direct labour. Particular emphasis on hydraulics, River and Canal Works and structures in concrete—mass, reinforced, prestressed, and steel.

Experience in specification and Bills of Quantities essential. Salary starting at £1045 rising to £1265 per annum ; Contributory Pension Scheme ; certain railway travelling concessions.

Apply in writing, giving age and experience to : Divisional Staff Assistant, British Waterways, "Willow Grange," Church Road, Watford, Herts.

Closing date, 27th January, 1960. E8604

PUBLIC APPOINTMENTS

GREAT YARMOUTH WATERWORKS COMPANY

APPOINTMENT OF CIVIL ENGINEERING STAFF

Applications are invited for the following appointments :—

(a) DEPUTY ENGINEER at a salary of £1310, rising, subject to satisfactory service, by annual increments of £60, £50, £50, £50 to a maximum of £1520 per annum.

The person appointed to this position would be required to occupy a house provided by the Company, rent and rates free, and valued for superannuation purposes at £80 per annum. A car allowance of £180 per annum would also be paid.

(b) SENIOR ENGINEERING ASSISTANT, at a salary of £1220–£1375 (A.P.T. V).

The Company will assist the successful candidate for post (b) to obtain housing accommodation if required.

Both posts are permanent and pensionable, subject to satisfactory medical examination.

Candidates for the post of Deputy Engineer must be qualified Civil Engineers with considerable experience in the design and operation of works of water supply.

Candidates for (b) must be qualified Civil Engineers, preferably with some experience of water supply and capable of undertaking the design and supervision of new works construction.

A considerable and varied programme of capital works extensions, &c., is planned or in progress.

Applications, giving full details of qualifications and experience, age, present and past employers and accompanied by not less than two testimonials, one of which must be from the present employer, to reach the undersigned, from whom any further information may be obtained, as soon as possible but in any case not later than the 6th February, 1960.

S. A. S. WALTON, O.B.E., A.M.I.C.E., M.I.W.E., Engineer.

84, York Road, Great Yarmouth. E8630

AIR MINISTRY

LONDON AND PROVINCES

ENGINEERING DESIGNER DRAUGHTSMEN

Air Ministry Works Designs Branch requires in London and Provinces ENGINEERING DESIGNER DRAUGHTSMEN experienced in preparation of pipework and mechanical and electrical plant layouts. Candidates should have served recognised apprenticeship or had equivalent training and also have had practical experience. O.N.C. an advantage. Financial assistance and time off given for recognised courses of study. Promotion and pension prospects. Five-day week with 18 working days' leave per year initially. Overseas tours for which special allowances granted.

Salary in London ranges from £680 (at age 25) to £900 per annum for men ; from £673 to £868 per annum for women. Somewhat lower in Provinces. Commencing salary dependent on age, qualifications and experience.

Applicants, who must be natural born British subjects, should write to Air Ministry, W.G.c, Lacon House, Theobalds Road, London, W.C.1, or to any Employment Exchange (quoting Order No. Kings Cross 3743), giving age, details of training, qualifications, full particulars of former posts held, and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. E8431

KINGSTON HOSPITAL

(534 BEDS)

WOLVERTON AVENUE, KINGSTON-UPON-THAMES, SURREY

RESIDENT ASSISTANT ENGINEER

Applications are invited for the appointment of RESIDENT ASSISTANT ENGINEER from candidates who have completed an apprenticeship in mechanical engineering and have experience, preferably in a hospital, of the principles and practice of the efficient operation of steam and oil-fired boiler plants. Ordinary National Certificate in Mechanical Engineering desirable. Modern maisonette available at reasonable rental. Pension scheme in force. Salary scale : £575 by £25 (5) to £700 per annum, plus London Weighting (commencing point according to previous experience).

Apply, with details of age, qualifications and previous experience, with names of two referees, to Group Secretary, Kingston Group Hospital Management Committee, 35, Coombe Road, Kingston-upon-Thames, Surrey. E8626

BRITISH RAILWAYS

WESTERN REGION

STRUCTURAL DRAUGHTSMAN

Applications are invited for STRUCTURAL DRAUGHTSMAN experienced in preparing estimates and contracts for the supply and erection of steel and concrete bridges, &c. Drawing Office and costing experience essential. Salary range £833–£903.

Travel concessions, holidays with pay with prospects of promotion and permanency with membership of Superannuation Fund.

Applications, stating age, previous experience, &c., to Chief Civil Engineer, B.R. Western Region, Paddington Station, London, W.2. E8556

PUBLIC APPOINTMENTS

AMENDED ADVERTISEMENT

BOROUGH OF SLOUGH

LANGLEY HIGH STREET SEWERAGE SCHEME

RESIDENT ENGINEER

RESIDENT ENGINEER required, to supervise laying of up to 21in. diameter C.I. Soil Sewer and up to 45in. diameter Concrete Tube Surface Water Sewer, together with ancillary works. Duration of contract approximately 12 months, with possibility of extension of service for an additional period of up to 2 years for further schemes. Appointment terminable by 2 months' notice on either side.

Salary : £1500–£1600 per annum, plus "Casual User" car allowance. Housing Accommodation for married candidate, if required.

Applications, stating age, present and previous appointments, details of qualifications and experience, and names and addresses of 2 referees to reach Borough Engineer, Town Hall, Slough, Bucks., by 8th February, 1960. E8622

NORTH THAMES GAS BOARD, MONCK STREET, WESTMINSTER, S.W.1

SENIOR DRAUGHTSMAN

SENIOR DRAUGHTSMAN required by North Thames Gas Board at Monck Street, Westminster, S.W.1, for the design and detailing of reinforced concrete structures and foundations associated with gas works.

Candidates should possess the Higher National Certificate as a minimum qualification. Commencing salary will be within the range £763 to £962 per annum, according to qualifications and experience.

The appointment will be of a permanent nature and the successful candidate will be required to join the Board's staff contributory pension scheme.

Applications, stating age, qualifications and experience, should be sent within ten days of the appearance of this advertisement, to the Staff Controller, North Thames Gas Board, Kensington Church Street, W.8, quoting reference TE/767. E8631

MIDDLESEX COUNTY COUNCIL

TECHNICAL ASSISTANTS

TECHNICAL ASSISTANTS required initially in Westminster to assist in drawing-office on the layout of cold and hot water services. Salary up to £910 per annum for suitable applicants. Unestablished. Prescribed conditions.

Details to County Architect, 1, Queen Anne's Gate Buildings, Dartmouth Street, S.W.1, by 8th February. (Quote B.792E.) E8610

WILMOT BREEDEN FELLOWSHIP

Applications are invited for a Fellowship, to be held in association with the College of Advanced Technology, Birmingham. The value of the Fellowship, which is for a two-year term, is £1000 per annum.

A candidate for the Fellowship should normally have had two or three years' research or industrial experience. He should have an Honours Degree or equivalent qualification and be acceptable to the College of Advanced Technology as a research fellow.

The Wilmot Breeden Fellow would engage in an enterprise of such a character as to require the facilities both of the College and the Company, his time being spent at both. His enterprise may have the character of Scientific Research, Design, Development, a combination of some or all of these, or in some other way to be appropriate to the activities of Wilmot Breeden. The Company is especially concerned with Mechanisms, Electro-Chemistry, Metal Finishing, Metallurgy, Metal Formation, Hydraulics, Electronics.

Full details may be obtained on application to Mr. F. Sargeant, Secretary, Wilmot Breeden Fellowship Committee, Amington Road, Birmingham, 25.

Final applications must be received by the Secretary before 1st May 1960. E8473

TENDERS

MADRAS PORT TRUST

The Office of the Chief Engineer, Madras Port Trust, Madras, India, invites TENDERS for the following.

TENDER ENQUIRY No. D/40332/59/E.P.

For the SUPPLY of 2 (Nos.) 5-ton PORTAL CRANES. Lifts above/below rail level are 50/45ft approximately. Maximum radius 65ft.

Specifications, drawings, &c., relative to the above can only be obtained from the Deputy Chief Accounts Officer (Engineering), Chief Engineer's Office, Madras Port Trust, Madras, India, on payment of £1 10s. per set, which is not refundable. Tenders are to be returned direct to the Chief Engineer's Office (at C Warehouse), Madras Port Trust, so as to reach there not later than 2.30 p.m. on 27th April, 1960.

Specimen copy of the above specification is available for examination at India Store Department, Engineering Branch, Bromyard Avenue, Acton, London, W.3, under reference S.3981/59/NSC/ENG.2. E8611

TENDERS

COMMISSIONERS FOR THE PORT OF CALCUTTA

CHIEF MECHANICAL ENGINEER'S DEPARTMENT

INVITATION TO TENDER

TENDERS are invited from experienced firms for the Construction, Supply and Delivery of One 250-ton CHAIN TESTING MACHINE at the Port of Calcutta.

Tender forms and specifications may be obtained from Messrs. Rendel, Palmer and Tritton, Consulting Engineers and London Agents to the Commissioners, 125, Victoria Street, Westminster, London, S.W.1, upon payment of £1 10s. (One Pound Ten Shillings) per copy and at the office of the Chief Mechanical Engineer to the Commissioners for the Port of Calcutta, 8, Garden Reach Road, Kidderpore, Calcutta, 23, India, on production of a receipt for Rs.20/- (Twenty Rupees) for each copy, from the Commissioners' Treasurer at 15, Strand Road, Calcutta 1, India. This amount is not refundable under any circumstances.

Tenderers before submission of Tenders must deposit with Messrs. Rendel, Palmer and Tritton or the Commissioners' Treasurer an amount to the extent of 1% (One per cent) of their tendered value as Earnest Money, which will be refunded to the unsuccessful tenderers on the award of the Tender being made and in the case of the successful Tenderer he shall have to deposit a further sum which, together with the Earnest Money already deposited shall equal to 10% (Ten per cent) of the contract value and be retained as Security Money for the successful execution of the contract.

Tenders in sealed envelopes, endorsed on the outside "Tenders for 250-ton Chain Testing Machine' are to be submitted in triplicate of which two copies are to be sent to the Chief Mechanical Engineer and the remaining copy to the Consulting Engineers so as to reach them not later than 10 a.m. G.M.T. in London and 3 p.m. I.S.T. Calcutta, on Thursday, the 21st April, 1960.

Tenders will be simultaneously opened at the above two premises shortly after the closing time referred to above and any tenderer who wishes to be present at the time of opening may do so.

Quotations from the Tenderers must be firm and remain open for a period of 16 weeks from the closing date of Tender.

The Calcutta Port Commissioners do not bind themselves to accept the lowest or any Tender and reserve the right to accept or reject any Tender without assigning any reason.

S. K. MITRA, Chief Mechanical Engineer.

E8563

SHEFFIELD CORPORATION WATERWORKS

YORKSHIRE DERWENT SCHEME

TENDERS FOR LOW LIFT PUMPS

TENDERS are invited from Pump Manufacturers for the SUPPLY and INSTALLATION of the WATER PUMPS and MOTORS for the low lift pumping station for the Yorkshire Derwent scheme of supply. The station will be capable of raising over 15 m.g.d. through heads of between 25ft. and 35ft.

Persons wishing to Tender should apply for the necessary documents, which will include instructions regarding the method and date of submission, to the General Manager and Engineer, Water Department, Town Hall, Sheffield, 1. E8614

INDIA STORE DEPARTMENT

The Office of the Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the following :

For the SUPPLY of 15 Nos. GLIDER LAUNCHING WINCHES with 100 b.h.p. petrol engine to launch Gliders up to 550 kg.

Specification, &c., can be obtained from the Co-ordination Branch, India Store Department, Bromyard Avenue, Acton, W.3, at a cost of 10 shillings per tender. The Tenders are due to be returned to India Store Department, at the above address, so as to reach them by 2 p.m. on Monday, 29th February, 1960.

Specimen copy of the above specification can be seen at Engineering Branch, India Store Department, Acton, W.3, under the following reference 2360/59/ENG.2. E8567

BOROUGH OF BRIDLINGTON

SUPPLY OF PUMPING PLANT

TENDERS are invited for the SUPPLY and INSTALLATION of TWO SETS OF DUPLICATE PUMPING PLANT of 25,000 and 35,000 g.p.h., electrically operated and automatically controlled. Contract documents, including form of Tender, obtainable from the Water Engineer and Manager, 11, Marton Road, Bridlington, upon payment of a deposit of Two Guineas, refundable on receipt of bona fide Tender. Tenders to reach undersigned by 10th March, 1960.

S. BRIGGS, Town Clerk.

Town Hall, Bridlington, 18th January, 1960. E8629

INDIA STORE DEPARTMENT

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, W.3, invites TENDERS for the SUPPLY of the following :

For 8 items of various quantities of : TUNGSTEN CARBIDE-TIPPED REAMERS, CUTTERS, BORING TOOLS, MILLING HOBS, &c.

Tender forms, price 10s. are obtainable from the above address; applications should quote reference 2034/59 ENG.1. The opening date for Tenders is Thursday, 18th February, 1960. E8579

BOOKS and PUBLICATIONS

HMSO

Scientific and Engineering Manpower in Great Britain 1959

Is supply keeping pace with demand and will it continue to do so ? This is the question which this report seeks to answer. It compares the scientific and engineering manpower situation in 1959 with that in 1956 and estimates how the position will develop by 1962. This is the second survey of its kind, the first having been published in 1956. (Cmnd. 902) 3s. (*post* 2d.)

Mechanical Engineering Research

Annual Report covering the work of the six Divisions of the Laboratory during 1958. Illustrated. 4s. 6d. (*post* 5d.)

From the Government Bookshops or through any bookseller

HMSO

Enter No. 971 on reply card

New Books

AVAILABLE ENERGY AND THE SECOND LAW ANALYSIS

By EDWARD A. BRUGES, B.Sc., Ph.D., A.M.I.Mech.E., *University of Glasgow*. 1959. *Price* 25*s*.

This book shows how a fuller understanding of energy changes in the thermodynamic systems may be obtained using the concept of available energy. It is specifically designed as a teaching aid for the advance undergraduate taking an Honours course who will carry this specialized knowledge into industry. This text also provides a modern approach for those practising development and design engineers, physicists, and chemists now distantly acquainted with theory.

CHEMISTRY FOR ENGINEERS An Introductory Course

By EDWARD CARTMELL, B.Sc., A.R.I.C., *University of Southampton*. 1959. *Price* 25*s*.

This volume provides an elementary treatment of chemistry as a background study for all branches of engineering science. Contemporary views on chemical theory are presented in simple language; the fundamental principles being illustrated by carefully chosen examples of practical engineering importance. The book is mainly for engineering students starting degrees or Higher National Certificate Courses.

There are two main themes—the chemistry of power production and the chemistry of materials. The traditional fuels and materials are fully discussed, and there are sections dealing with recent exciting developments such as nuclear power production, rocket fuels and synthetic plastic materials. Recent work on topics of essential interest to all engineers is discussed in chapters on metallic corrosion, water treatment and lubrication.

TEXTILE ENGINEERING PROCESSES

Edited by ALFRED H. NISSAN, *Research Professor, Rensselaer Polytechnic Institute, Troy, New York*. 1959. *Price* 60*s*.

This is a text for students wishing to qualify as textile engineers either through passing university examinations on the subject or through the examination for Associate Membership of the Institution of Mechanical Engineers which has a paper on textile engineering.

Since textile engineering is concerned with both the properties of the fibres, yarns and fabrics being processed as well as the machinery used in these processes, the book contains chapters covering both aspects of these problems. A third and persistent factor in textile engineering is the interaction between textile materials and the atmosphere. A chapter on air properties supplies the need here.

Butterworths Scientific Publications

4 & 5 Bell Yard, London, W.C.2

Enter No. 972 on reply card

"A complete library in two volumes . . ."

KEMPE'S ENGINEERS YEAR-BOOK

Edited under the direction of the Editor of "The Engineer"

1960 Edition price **87/6** *(plus postage 2/6)*

from technical booksellers or direct from the publishers

Kempe's Engineers Year-Book, 28 Essex Street, Strand, London, W.C.2

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TENDERS

METROPOLITAN WATER BOARD

TENDERS FOR THE SUPPLY OF STORES, &c.

TENDERS are invited for the SUPPLY of the following STORES and SERVICES for the period of 12 months commencing 1st April, 1960 :

Contract No.	
1	Cement, tarmacadam, concrete slabs, earthenware bases, firebricks, flotton, stock and engineering bricks.
2	Brushes, brooms and handles.
3	Cast and spun iron straight pipes, cast iron specials.
4	Uniform clothing and caps, mechanics' overalls, rubber boots, shoes, &c.
5	Cotton waste, cleaning cloth, wipers, hemp, tarpaulins, &c.
6	Motor tyres, tubes, batteries, oils, &c.
8	Mild steel bars, plates, sheets, &c.
9	Black bolts and nuts, screws, files, shovels, &c.
10	Lead, pipe, solder, sheet, &c.
11	Fuel oil, kerosene, motor spirit.
12	Special lubricating oils.
13	Soaps, polishes and cleansers, oilman's sundries, paper towels and toilet rolls, &c.
14	Rubber and canvas insertion sheet and washers ; suction, delivery, chemical and fire hose, &c.
19	Small iron castings, valve, hydrant and stopcock boxes, &c., non-ferrous castings.
20	Stopcocks, ferrule stopcocks, unions, disc fittings, hydrant outlets and caps.
21	Sluice valves, fire hydrants and parts, extension spindles, hydrant indicator plates, &c.
23	Periodical inspection, repair and maintenance of weighing apparatus.
24	Electric lamps and fluorescent tubes.
25	Steam, smithy and house coal, and coke.
26	Removal of furnace refuse.
27	Photo prints, &c.

Tenders must be submitted on the official forms, which may be obtained from the Chief Engineer by personal application at the offices of the Board (Room 171) or upon forwarding an addressed envelope (not smaller than 15in. by 10in.) and enclosing stamps value 1s. to cover postage, &c.

Applicants should refer to the number of the contract for which Tender forms are required.

Tenders, enclosed in sealed envelopes, addressed to the undersigned and endorsed in the manner indicated in the form of Tender, must be delivered at the offices of the Board (Room 122) not later than 12 noon on Thursday, 4th February, 1960.

The Board do not bind themselves to accept the lowest or any Tender.

S. D. ASKEW,
Clerk of the Board.

Offices of the Board,
New River Head,
Rosebery Avenue,
London, E.C.1. E8472

DUNMOW RURAL DISTRICT COUNCIL

CONTRACT NO. 17

LITTLE HALLINGBURY SEWERAGE AND SEWAGE DISPOSAL

TENDERS are invited on a fixed price basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57 for the CONSTRUCTION of SEWERAGE AND SEWAGE DISPOSAL WORKS at Little Hallingbury.

The sewerage comprises in all the laying of about 2260 linear yards of 6in. diameter S.G.W. sewer.

Extensions are to be made to the existing sewage disposal works and comprise a pyramidal sedimentation tank, biological filter, concrete sludge digestion tank, concrete sludge drying beds, extension to existing sand filter and humus tank and alteration to ancillary pipework, site roads and fencing.

General Conditions of Contract, Specification, Bills of Quantities and Drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. & D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after, 25th January, 1960, on payment of a deposit of ten guineas, refundable only to Contractors who submit bona fide tenders and return all documents and drawings. Deposit cheques should be made payable to Dunmow Rural District Council.

The Council do not bind themselves to accept the lowest or any tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender endorsed "Tender for Sewerage Contract No. 17," and delivered at the office of the undersigned by noon on 4th March, 1960.

A. H. BURTON,
Clerk of the Council.

Council Offices,
Dunmow, Essex. E8600

EDUCATIONAL

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

POST-GRADUATE COURSE IN PRODUCTION ENGINEERING.

Applications are invited from Graduates for a one-year full-time Course in Production Engineering leading to the Diploma of the Imperial College (D.I.C.), which will begin in October, 1960.

Further particulars can be obtained from the Registrar, Imperial College, London, S.W.7. E8561 E

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

EDUCATIONAL

CHESHIRE EDUCATION COMMITTEE

CHESHIRE COUNTY TRAINING COLLEGE, ALSAGER

ONE-YEAR COURSE OF TEACHER TRAINING FOR CRAFTSMEN

At the request of the Ministry of Education, the Cheshire Local Education Authority will provide, at the above-named College, from September, 1960, a new ONE-YEAR COURSE designed to give skilled Craftsmen teacher training to enable them to take up posts as teachers of Handicrafts in Secondary Schools.

Applications are therefore invited for admission to this Course from men who already possess appropriate qualifications, such as a Full Technological Certificate of the City and Guilds of London Institute, or a Higher National Certificate or Higher National Diploma, and who wish to be trained as teachers.

The particular academic requirements of individual students and the application of their craft skills to the needs of schools will be specially studied. The year of training will include periods of teaching in schools.

The basic salary scale for qualified assistant teachers is £520 per annum, rising by annual increments of £27 10s. and one final increment of £40, to a maximum of £1000. Additional increments are given for approved qualifications and training. Account may also be taken of approved industrial experience acquired over the age of 21, up to a maximum of twelve increments.

Anyone needing further advice about the Course, the qualifications required, the grants available to students while attending the Course, and the teaching prospects available at the end of the Course, should communicate with the Principal, the Cheshire County Training College, Alsager, Stoke-on-Trent. Applications for admission to the Course should also be made to the Principal. Early application is advised.

JOHN G. KELLETT,
County Hall, Director of Education,
Chester. E8625 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A MAJOR COMPANY REQUIRES A HIGH LEVEL TECHNICAL SALES REPRESENTATIVE in the Paper-making Machinery field. Applications are invited from Engineers or Operators thoroughly conversant with the construction and operation (but not necessarily the design) of paper-making machines. Sales experience is not essential. Enthusiasm is. Young men in the 30–35 age group, already in the four-figure salary range, are most likely to find this opportunity attractive. Further training in the precise field of operation is envisaged and there will be considerable scope for increased responsibility later. The commencing salary and normal supplementary benefits are in line with the importance of this appointment.—Full details please to BOX No. E8571, "The Engineer." A

A VACANCY EXISTS FOR A SENIOR DRAUGHTSMAN with a Company within the Rank Organisation. The work is of an interesting nature and requires experience of small mechanisms and/or precision instruments. Minimum qualifications O.N.C. Good conditions and salary for suitable applicant.—Please apply, giving details of age, education, &c., to Personnel Officer, Rank Precision Industries Ltd., Woodger Road, Shepherd's Bush, W.12. E2693 A

A VACANCY EXISTS IN THE DAIRY SERVICE DEPARTMENT for a person to deal with work of a technical/practical nature, preferably with some qualification in chemistry or Food Technology but must also have a very definite leaning towards mechanical engineering. Alternatively a mechanical engineer might suit. The work will mostly deal with food processing equipment and the successful candidate will operate from Crawley, although considerable travelling is envisaged. Apply in writing, giving details of age, experience, and salary required, to Personnel Officer, The A.P.V. Co. Ltd., Manor Royal, Crawley, Sussex. E8634 A

APPLICATIONS ARE INVITED from ambitious and resourceful men to fill the position of TECHNICAL ASSISTANT to the Sales Manager of Electric Lamp Machinery Manufacturers near London. A permanent, progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade.—Applications, with full particulars of education, experience and salary required, to BOX No. E171, "The Engineer." A

CHIEF ENGINEER required by firm of Textile Printers. Must have held a responsible position and had experience of steam and electrical power generation, distribution and utilisation, together with process plant maintenance. Ability to supervise present and future rebuilding and re-equipment programme essential. House available. Pension scheme and good prospects for suitable applicant. —Apply in confidence giving full details of career, qualifications and salary required to : General Manager, Stead, McAlpin & Co., Ltd., P.O. Box 1, Carlisle. E2682 A

CONSULTING ENGINEERS urgently require additional staff in London and Darlington, ENGINEERS and DRAUGHTSMEN for both reinforced concrete and steelwork.—Full particulars to F. R. Bullen and Partners, Dacre House, Dean Farrar Street, S.W.1. E8422 A

CONSULTING ENGINEERS, Westminster, require capable ASSISTANTS for varied reinforced concrete, steel and foundation work. 5-day week. Luncheon vouchers.—Write or 'phone, Maurice Nachshen and Partners, 58, Victoria Street, S.W.1. (Vic. 0285.) E8550 A

Classified Advts. continued on page 98

SITUATIONS VACANT

CHIEF ENGINEER

An international consumer Rubber Goods Manufacturer, acknowledged leader in its branch of the industry, wishes to make a high level appointment in engineering management, leading to position on the Board.

The Company has reached its present outstanding position through steady continuous expansion and is at present building a completely new plant.

The Chief Engineer will be responsible to the Managing Director for all aspects of the Company's diverse engineering activities—mechanical, electrical, hydraulic, constructional and industrial.

The most important requirement is proved ability and experience in leading qualified men. Candidates must be able to show evidence of this in terms of previous industrial management posts. They must be fully qualified in one or more of the above engineering fields. Finally, they should be at least 35 years of age and earning £2000 p.a.

The location of the appointment is in North London and terms of employment will be appropriate to the highly important post.

Please write fully.—BOX No. E8598, "The Engineer."

DESIGNER DRAUGHTSMAN

Aged 30/35, required by engineering firm in East Essex, to develop new ideas and to design rotating plant accordingly, to deal with problems of water treatment and purification.

Applicants must have had a workshop training in mechanical engineering, academic proficiency up to H.N.C. standard, and practical drawing-office experience in a responsible capacity.

Write, stating salary required and giving details of age, education and experience, to BOX No. E8545, "The Engineer." A

DEVELOPMENT ENGINEER

A qualified Mechanical Engineer, aged about 40, is required by a firm in East Essex, to develop new ideas arising from market research, which will also form part of the appointment, into problems of water treatment and purification.

Practical experience in the design of rotating and static plant for such applications is essential, and the applicant should have had a sound academic training and a workshop apprenticeship in mechanical engineering.

Write, stating salary required and giving details of age, education, qualifications and experience, to BOX No. E8544, "The Engineer." A

DEVELOPMENT ENGINEER required for well-known Engineering Company expanding existing Foundry capacity. Applicants must have experience of machine design covering mass production of small castings, plant layout and be capable of seeing projects through from drawing-board to full production, educated to H.N.C. Write, stating full details of experience and salary required.—BOX No. E2677, "The Engineer." A

DRAUGHTSMAN required for work on Valve Design; all applications will be treated in confidence.—Apply in writing to Chief Engineer, Alley and MacLellan, Ltd., Bromyard Road, Worcester. E8618 A

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of rrefractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733–£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15.

E174 A

DRAUGHTSMEN

Versatile Engineering Draughtsmen with general experience are required by a Plastics Manufacturing Company employing approximately 2000, with Engineering Department of 400. The work involved includes machinery design and layout, &c., and is of considerable interest. O.N.C. or H.N.C. desirable. A.E.S.D. rates and above. Good transport facilities and working conditions. Contributory Life Assurance/Pension Scheme.

Apply, giving details of training, qualifications, experience, age and career to date, to
Personnel Manager,
BX Plastics, Ltd.,
Brantham Works,
Nr. Manningtree, Essex.

E8591 A

DRAUGHTSMAN REQUIRED for Tar and Heavy Chemical Works in East London area. Knowledge of chemical work an advantage. Age 21–30. Wage according to experience and qualifications. Permanent and superannuable post.—BOX No. E2683, "The Engineer." A

ENGINEER for Pakistan, with practical knowledge of manufacture of collapsible tubes. Contract for three to five years, outward and return passages paid.—Write, giving full details of past experience, stating salary required and enclosing photograph if possible, to BOX No. 1889, c/o Abbotts, Eastcheap, London, E.C.3. E8617 A

ENGINEER required, with experience in the installation of light mechanical packing machinery, by Johnson & Johnson Export Ltd. Age 28–40. Engineering degree essential, together with knowledge of European languages, preferably French. Successful applicant must be prepared to travel abroad. Commencing salary £1500 per annum.—Apply, giving full information, to Personnel Manager, Johnson & Johnson (Gt. Britain), Ltd., Wrexham Industrial Estate, Wrexham. E8619 A

ENGINEERING DRAUGHTSMAN, experienced in all aspects of services layout. Work in connection with the modernisation and replacement of services equipment in a large Institution. Duties entail thorough knowledge of steam, hot water, air distribution and associated equipment. Salary will depend on experience and qualifications, but it is expected to be in the range £750–£1000 p.a.—Applications, giving details of training, experience and qualifications to BOX No. 3133, c/o Charles Barker & Son, Limited, Gateway House, E.C.4. E8589 A

ENGINEERING, PHYSICS AND SCIENCE GRADUATES OR EQUIVALENTS required for new appointments in the following fields:

(1) Fundamental and applied research on the dynamic behaviour of machine tools and problems associated with automatic control.
(2) Applied research and development of press working processes, cold extrusion and other new techniques for the forming of metals.
(3) Applied research on machining processes; initially work will be concerned with the appraisal of new machining developments or studies of machining costs on a comprehensive scale.
(4) Research, design and development of a variety of mechanical engineering equipment including special machine tools, presses, mechanisms, test rigs, &c.

Successful candidates will be expected to take complete responsibility for projects from conception to completion. Capacity for creative thinking and initiative are important. The conditions of employment are attractive and there are excellent prospects for advancement. Superannuation scheme. Removal expenses paid.—Send full details in confidence to the Secretary, Production Engineering Research Association, Melton Mowbray, Leics. E8480 A

ENGINEERS with considerable experience of construction of pipeline, pump stations and tank farms, required by important firm for Middle East.—Write to BOX No. 3132, c/o Charles Barker and Son Limited, Gateway House, London, E.C.4. E8577 A

ENGINEERS AND DESIGN DRAUGHTSMEN required for design and construction of plant for Continuous Casting of Steel. Experience of steelworks or similar heavy mechanical equipment is required, and some knowledge of hydraulics would be an advantage. Minimum standard H.N.C. These are permanent posts with excellent prospects in a new and rapidly expanding field of steelworks engineering. Five-day week, pension scheme, canteen.—Apply, with full details in confidence, to Managing Director, Continuous Casting Company, Ltd., 52, Queens Road, Weybridge, Surrey. E2689 A

FULLER ELECTRIC, LIMITED,

have vacancies for

PROCESS PLANNING ENGINEERS

Applicants should have had workshop experience of piecework as an operator particularly in a Heavy Fabrication and Welding Shop. Men aged 25–35 possessing O.N.C. (Mech.) preferred, but older men with extensive practical experience will be considered.

TIME STUDY ENGINEERS

Applicants should possess sound technical and practical engineering knowledge and experience together with a proven ability to implement incentive schemes from time studies and synthetics.

Applications quoting age, experience, education and salary required to: Personnel Officer, Fuller Electric, Limited, Fulbourne Road, Walthamstow, E.17.

E8596 A

HEATING & VENTILATING ENGINEER, experienced all types ventilating and heating, capable taking complete charge of contracts. Good salary, pension scheme and L.V.—Write in confidence, giving age, experience and salary expected to The Secretary, Carrier-Ross Engineering Co. Ltd., 22A, Cavendish Square, London, W.1. E2685 A

HEAT TRANSFER ENGINEER, A.M.I.Mech.E. or H.N.C., for work on Extended Surface and Plain Tube Heat Exchangers Factory in West Sussex. Prospects excellent in rapidly developing company. Must be willing to travel.—BOX No. E8613, "The Engineer." A

INTERMEDIATE DRAUGHTSMAN wanted for Design and Development Work on Portable Pneumatic and Electric Tools. N.W. London.—Write in first instance giving age, experience and salary required to Chief Designer, BOX No. E8583, "The Engineer." A

MAJOR PETROLEUM COMPANY has vacancies for qualified Automotive Engineers as TECHNICAL SALES REPRESENTATIVES in the North of England. Candidates should be between 25 and 35 years of age, must be Associate Members or Graduates of the Institution of Mechanical Engineers, dependent on age, and have served with a Commercial Vehicle Manufacturer. They must possess a sound knowledge of C.I. engines and of all types of final drive, and have some service department and possibly sales experience. Starting salary commensurate with qualifications and experience, excellent conditions of employment and plenty of scope for men of above average intelligence and personality. Apply, giving full details of age, qualifications and experience. Replies can only be sent to those selected for interview.—BOX No. E8543, "The Engineer." A

JACKSON BROS. (OF KNOTTINGLEY), LTD.

require a DRAUGHTSMAN for work in modern, glass-producing factory on bottle-mould design. Experience in this class of work is desirable, but not essential. Canteen facilities.—Apply Personnel Officer, Jackson Bros. (of Knottingley). Ltd., Headlands Lane, Knottingley, Yorkshire.

E8484 A

LEADING PETROLEUM COMPANY have vacancies in the U.K. for qualified ENGINEERS. Candidates should have had thorough training in workshops and possess either Corporate Membership of the Institutions of Civil or Mechanical Engineers or have passed parts A and B of one of these Institutions' examinations or have qualifications entitling them to exemption from such examinations. Experience on pumps and pipelines or building construction would be advantageous. Excellent conditions of employment and starting salary appropriate to qualifications and experience. Apply, giving full details of age, qualifications and experience. (Replies can only be sent to those selected for interview).—BOX No. E8520, "The Engineer." A

MANAGEMENT ENGINEER

Large Middle East oil company staff position overseas. Responsibilities include analysis of current programmes and controls, policy and procedure, determination, development of recommendations, installation of approved changes, training national management analysts.

Successful candidates should be between 35–45 years, have a college degree, practical or academic training and experience in application of industrial engineering principles. Broad administrative experience in large industrial company preferred, not necessarily oil company.

Salary and benefits liberal, housing provided.

Please send complete résumé or curriculum vitae.—BOX No. E2686, "The Engineer."

MECHANICAL ENGINEERING DRAUGHTSMAN required, with Jig and Tool experience. Age 22-24 years. Good opportunity for right applicant. Generous Pension and Free Life Assurance Scheme. Five-day week. Holiday arrangements respected.—Andre Rubber Co. Ltd., Kingston By-Pass, Surbiton, Surrey. E8586 A

METALLURGIST

Non-ferrous metal manufacturers in S.W. Lancashire require an additional Graduate Metallurgist in their process control department. Industrial experience is not essential providing the candidate possesses the personal qualities and ability required to work as a member of a small enthusiastic team. This is a staff appointment and a superannuation scheme is in operation.

Full details with application.—BOX No. E8633, "The Engineer."

MISSING!

From a small, hardworking team of Development Engineers, engaged on lifting equipment projects in a Manchester Factory, a suitable DESIGNER with modern theoretical and practical experience of welded structures. Will anyone with these qualifications, desirous of joining the team, apply to BOX No. E8572, "The Engineer."

OPPORTUNITIES FOR ENGINEERING TRAINING.—We are looking for young men with a University Degree or H.N.C. in Mechanical or Chemical Engineering to train for future engineering posts of responsibility within our organisation. Mobility is important, since the persons appointed may be required to work for indefinite periods at any of our eight works. Subsequent appointment to specific engineering posts depends on progress. Initial salary according to qualifications and experience.—Write for application form to Personnel Manager, Imperial Smelting Corpn., Ltd., Avonmouth, Bristol, quoting reference ET/TE. E8615 A

PERSONAL ASSISTANT to General Manager of Mechanical Handling Division of Group of Companies required. Applicants must have wide experience of all types of Mechanical Handling and Screening Plant, and preferably some knowledge of Control Systems for these plants. Only men of initiative capable of handling complete schemes, including development and estimating work, will be considered. Professional qualifications preferable but not essential. Position offers scope for advancement to the right man. Contributory Pension Scheme.—Write in confidence giving details and salary expected to BOX No. E2684, "The Engineer." A

REQUIRED—
PLANT AND MACHINERY VALUER

Must be fully experienced and able to work without supervision. Permanent post. Pension scheme, 5-day week.—Full particulars, in confidence to: Leopold Farmer and Sons, 46, Gresham Street, London, E.C.2. Telephone MONarch 3422.

E8576 A

PLATT BROS. AND CO., LTD., Oldham, require a SENIOR DRAUGHTSMAN with experience of machine design, H.N.C. qualification, and a JUNIOR DRAUGHTSMAN with experience of machine design, O.N.C. qualification, experience on textile machinery would be an advantage but not essential.—Apply by letter or in person to the Personnel Department, Arkwright Street, Oldham. E2692 A

PRODUCTION ENGINEER

Large engineering firm in Glasgow, engaged in medium-heavy engineering, requires a Production Engineer to take charge of established department responsible for Methods, Planning of Work, Jig and Tool Design, and Rate-fixing. This is an important post requiring wide knowledge of modern engineering practice and offering considerable scope to successful applicant. Initial salary commmensurate with experience. Contributory superannuation scheme.—Details of qualifications, experience and salary expected, to BOX No. 1411, Wm. Porteous and Co., Glasgow. E8607 A

QUALIFIED ENGINEER required for investigating vibration problems and assisting with the application of research results in industry. Applicant must be willing to travel and enjoy discussing problems with personnel at all levels of industry. Travelling expenses will be paid. Attractive salary and superannuation through F.S.S.U.—Full details to the Secretary (R.628), Production Engineering Research Association, Melton Mowbray, Leics. E8521 A

RESEARCH AND DEVELOPMENT ENGINEER

required

for work on the

COMBUSTION OF LIQUID FUELS

This position offers the successful candidate outstanding opportunities to carry out work, from fundamental research to commercial development, in the field of oil burning, in the newly-formed Research Department of one of the pioneer companies of this Industry.

Applicants should have a degree in Mechanical Engineering or equivalent qualifications. Experience either in combustion or aerodynamics is desirable but consideration will be given to candidates without this experience who are otherwise suitable.

The Company operates a contributory superannuation fund and a life assurance scheme.

Applications, which will be treated in strict confidence, should include details of age, education, experience and salary required, and be addressed to BOX No. E8575, "The Engineer."

SALES ENGINEER. Progressive valve manufacturing company has a vacancy for a Sales Engineer. Applicants should be between 25 and 30 years of age and have previous experience of selling speciality engineering equipment.—Full particulars including education, engineering training, previous experience, age and salary required to: The Managing Director, Warren, Morrison, Ltd., 41, St. James's Place, S.W.1. E2694 A

SALES MANAGER REQUIRED. Aged 30/40, for London office of well-known engineering company. Experience in sales of aluminium castings and assemblies, with particular reference to transport and railway applications essential.—BOX No. E8566, "The Engineer." A

SENIOR PROJECT DRAUGHTSMAN required for Mechanical Handling Plants. Applicants must be able to lay out schemes. Experience in Estimating an advantage but not essential. Good prospects.—W. W. Brown & Partners, Ltd., 72, Newman Street, London, W.1. E2660 A

STEEL WORKS PROJECT ENGINEER

An opening offering good prospects is available for a man of proved ability, qualified in the layout and operation of Steel Works Plant and the co-ordination of requirements for Heavy Shears, Handling Equipment and Ancillary Gear, &c.

Applicants should be able to guide general designs to meet specifications and supervise the manufacture and building of complete equipments.

In the first instance, please give full details of age, training and experience.

Write, BOX No. E8608, "The Engineer." A

SUB AGENTS AND ENGINEERS required for various Contracts throughout Scotland.—Write, giving details, age and experience, to Duncan Logan (Contractors), Ltd., Great North Road, Muir of Ord. E8609 A

THE MANCHESTER SHIP CANAL COMPANY

The Manchester Ship Canal Company invite applications for the appointment of ASSISTANT CIVIL ENGINEERS and DESIGN ENGINEERS on the established staff of the Chief Engineer. Scale of salaries: £805 at age 25, rising by annual increments to £1250 at 38, with prospects of promotion to higher grades at salaries up to £1720.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications, and should have experience in design, specifications, construction and maintenance of Civil Engineering Works. Harbour and dock experience is preferable but not essential.

Successful applicants will require to become members of the Company's Contributory Superannuation Scheme.

Applications, stating age, qualifications and experience, should be addressed to the Chief Engineer, The Manchester Ship Canal Company, Ship Canal House, King Street, Manchester, 2, not later than 13th February, 1960.

E8560 A

TWO ENGINEER SALESMEN required, one for Midland area and one for London area. Well educated. Mechanical Engineers. Not more than 38 years of age. Required to sell Pipework and general engineering products. Energetic and adaptable personalities. Must have selling experience.—BOX No. E2681, "The Engineer." A

SITUATIONS VACANT

TOOL AND MACHINE TOOLMAKERS

required for Methods Development workshop of large scale light engineering Organisation in North West London. Applicants should have experience in the manufacture and tryout of special purpose equipment associated with the production of components and automatic assembly in the field of instruments and light mechanism.—Applications will be treated in strict confidence and should be addressed to BOX No. E8578, "The Engineer."

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WORKS MANAGER

An interesting and responsible post is available in a rapidly expanding Company engaged in the manufacture of Accessories for the Motor Industry and situated in the London area. Applications are invited from qualified persons, age 30/50, who have had extensive Machine Shop, Tool Room and Production experience.

Ability to handle a large labour force and experience in negotiating with Trade Unions is of prime importance. The prospects are good.

Preference will be given to those with A.M.I.Mech.E. and A.M.I.P.E., or equivalent qualifications. The appointment arises because of retirement and offers a commencing salary of up to £2000 per annum for a suitable man.

Applications, covering career history to date and other relevant details, should be addressed in strict confidence, quoting Ref. A.H.—BOX No. E8601, "The Engineer." A

YOUNG ENGINEERS, with practical or design experience, who seek an opportunity to sell technical products to engineers, will be trained to sell and offered a career by leading London company.—Fullest particulars of education, experience and ambition to BOX No. E8585, "The Engineer." A

YOUNG GRADUATE ELECTRICAL ENGINEER required for work on electrical installation connected with development schemes relating to the Roadstone Industry. The position is progressive and has future prospects.—Written application giving full details of qualifications and experience should be sent to Development Manager, Tarmac Roadstone Limited, Ettingshall, Wolverhampton. E8590 A

LARGE MODERN STEEL FOUNDRY IN YORKSHIRE

requires a

CHIEF ENGINEER

to be responsible for all maintenance duties and for a large development programme. Wide knowledge of heavy engineering, together with civil engineering experience, is desirable. This is a senior executive position and will be remunerated as such.

A non-contributory pension scheme is in operation and assistance towards housing will be provided if necessary.

Replies, giving details of education and experience, together with an indication of salary required.—BOX No. E8498, "The Engineer." A

ROOTES GROUP
British Light Steel Pressings, Ltd., Warple Way, Acton, W.3. SHE 1230

VACANCIES FOR

TOOL ESTIMATOR

PHYSICAL LAYOUT DRAUGHTSMAN

SENIOR JIG AND FIXTURE DESIGN DRAUGHTSMAN

Good rates of pay and canteen facilities. Social and sports club. Interviewing hours Monday to Friday 8.30 a.m.–5 p.m. Apply Secretary. E8592 A

THE BAHRAIN PETROLEUM COMPANY, LIMITED,

require a

MAINTENANCE ENGINEER

This post is open to recent graduates in Mechanical Engineering, under 28 years of age, who are interested in all phases of planned maintenance of heavy plant and who have preferably some experience on pressure vessel, heat exchanger and pump repair or construction. It is intended that the selected candidate should train in Bahrain with a view to advancement to at least Area Engineer in the large and modern refinery there.

A good salary can be offered dependent upon qualifications, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves (passage paid for the former and generous assistance towards the latter) are also provided with participation in the Company's Pension and Provident Fund Schemes.

Apply in writing, quoting "MTC," with full particulars to: Caltex Services, Limited, Caltex House, Knightsbridge Green, London, S.W.1. E8562 A

BRITISH TRANSPORT COMMISSION

British Transport Commission invites applications for the following post:

Research Station, Docks and Waterways, Hayes Road, Southall.

SCIENTIFIC OFFICER

Salary Range £1045–£1150

Candidates should have good Degree in Physics or Engineering, with mathematical ability and knowledge of hydraulics. Practical experience in research or engineering an advantage.

Superannuation scheme. Certain travel facilities. Medical examination. Write, stating age, qualifications and experience, to Director of Establishment, British Transport Commission, 222, Marylebone Road, London, N.W.1, within 7 days. E8594 A

A.E.R.E. HARWELL

ASSISTANT CHIEF ENGINEER

The Works Services Department at Harwell is responsible for installation of plant and services to the requirements of a fast moving and exacting scientific programme. A highly skilled force of mechanical and electrical engineers, surveyors and building tradesmen, numbering 400 together with contractors' labour is engaged on this work. The Assistant Chief Engineer in charge is responsible for forward planning in consultation with Scientists and Design Engineers for a considerable amount of "in situ" modification of plant and services and for staff management.

Applicants should be Corporate Members of a Senior Professional Engineering Institution, and the possession of an engineering degree would be advantageous.

A progressive outlook and wide experience in the efficient organisation and control of plant installation, operation and maintenance by direct and contract labour is essential.

Salary: £2,400–£2,900 p.a.

Please send POSTCARD for details to Group Recruitment Officer (1540/25), U.K.A.E.A., A.E.R.E., Harwell, Berks. E8558 A

TECHNICAL MANAGER

required for old-established and progressive engineering firm of medium size known the world over.

Products cover high-quality medium-heavy to light mechanical and hydraulic machinery in small batches for a great variety of industrial applications both in production and research.

An intensive development programme is followed which must be maintained and augmented with suitable instrumentation of mechanical, electrical and electronic kinds.

Qualifications include thorough technical knowledge and practical experience of engineering, and ability both to control design staff and to foster the whole of the Firm's technical activities from a broad and progressive angle.

Fullest particulars should be given of academic qualifications, practical experience, posts held, type of work handled, and of contacts with industry and research establishments.

Write, stating age, present earnings and when available, to:

The Managing Director,
SAML. DENISON & SON, LIMITED,
HUNSLET FOUNDRY,
LEEDS, 10 E8568 A

CALTEX

THE BAHRAIN PETROLEUM COMPANY LIMITED

part of the world-wide
CALTEX GROUP OF COMPANIES

marketing petroleum products in the UNITED KINGDOM through the REGENT OIL COMPANY LIMITED, require GRADUATE MECHANICAL ENGINEERS and METALLURGISTS for process plant inspection and corrosion and materials engineering in Bahrain's modern oil refinery.

Duties will include inspection of all types of petroleum processing equipment; power plant boilers and auxiliaries; oil storage and distribution equipment; utilities; wharves, jetties and causeways; marine vessels; bridges; and oil field equipment. The work requires knowledge of A.S.M.E., A.P.I., T.E.M.A. and B.S. codes for the construction of pressurised equipment, design methods, maintenance engineering, materials of construction, process design, corrosion engineering and cost analysis. Men with metallurgical backgrounds would have opportunities to enter fully-equipped laboratories to specialise in materials or corrosion engineering.

Technical men with or without experience will do well to consider a career in this branch of engineering. The work presents unrivalled opportunities to gain wide experience quickly, with excellent prospects of promotion to senior posts in the oil industry.

Salary would be generous, in accordance with qualifications and experience, and free air-conditioned accommodation and a living allowance would be provided. An initial kit allowance, free medical attention and paid local and home leaves are also provided with participation in Pension and Provident Fund Schemes.

Apply in writing, quoting "INS," with details of qualifications and experience, to Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1. E8606 A

PROCESS PIPING SYSTEM ENGINEERS

Chemical or Mechanical Engineers are required for work on the design of process and utility piping systems for oil refinery and petro-chemical plants. The work involves the preparation of engineering flow diagrams and close liaison with our Process, Instrument, Mechanical Equipment, Plant Layout and Operating groups.

Applicants should have a University Degree in either Chemical or Mechanical Engineering and also at least two years' relevant post-graduate experience in industry.

Above average salaries will be paid to men with the required qualifications. Comprehensive personnel benefits include contributory Pension Scheme, Luncheon Vouchers, excellent working conditions, Social Club etc. When overtime is worked, payment is made for hours involved.

Please apply by letter to Personnel Manager,

KELLOGG INTERNATIONAL CORPORATION

7–10, CHANDOS STREET, CAVENDISH SQUARE, LONDON, W.1. *QUOTING REFERENCE G/152.*

E8597 A

Classified Advts. continued on page 100

SITUATIONS VACANT

BRITISH TRANSPORT DOCKS

Invite applications for the position of

ASSISTANT ENGINEER (MECHANICAL)

in the Chief Docks Engineer's Office, Hull Docks.

Applicants should preferably have had experience in docks mechanical engineering, including all types of appliances and machinery. Corporate Membership of the Institution of Mechanical Engineers essential. Salary range : £1315–£1590 per annum. Contributory superannuation scheme and certain rail travel facilities.

Applications, giving age, education, training, experience and qualifications, to : Staff and Establishment Officer, British Transport Docks (T.E.), 163, Euston Road, London, N.W.1, to arrive not later than Friday, 29th January, 1960.

E8595 A

SITUATIONS VACANT

ENGLISH ELECTRIC
require

RESEARCH AND DEVELOPMENT ENGINEERS

at

The Mechanical Engineering Laboratories, Whetstone, near Leicester,

for the Solid Mechanics Group, which undertakes both theoretical and experimental investigations relating to strength of materials and vibrations, including fundamental Research. Applications are invited from qualified engineers, physicists or mathematicians, in the age range 20–35, in particular from those interested in photo elasticity theory of structures or vibrations.

There is also a vacancy for a

STRUCTURAL ENGINEER

who will be employed on the application of minimum weight principles to the design of diesel locomotive structures in which the analytical work will be backed by both laboratory and field tests. The successful applicant will be a member of a team dealing with structural problems in general.

Please write, giving details of qualifications and experience to Dept. C.P.S., Marconi House, 336-7, Strand, London, W.C.2, quoting reference E1995F.

E8492 A

SITUATIONS VACANT

WORK STUDY ENGINEER

required by

W. H. ALLEN SONS & CO., LTD.,

to join the Work Study Section at their

PERSHORE WORKS

Candidates should have a sound engineering training with experience in work measurement and deriving synthetic times for costing and incentive schemes.

Good conditions of employment with contributory pension and life assurance schemes.

Write in confidence, stating experience and qualifications, to :

THE PERSONNEL MANAGER,
ATLAS WORKS, PERSHORE, WORCS.
(quoting ref. 829/247/CA.213)

E8570 A

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 O

BUSINESSES and PREMISES

SMALL ENGINEERING COMPANY REQUIRED, preferably with tax losses available. Geographical position secondary importance.—Please send full particulars Premises, Plant, &c., to Messrs. C. T. Moore & Co., Chartered Accountants, Adelaide House, London Bridge, E.C.4. E2687 L

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

600

FORK LIFT TRUCKS FOR HIRE

Modern Machines Only
Diesel & Battery/Electric
Capacities 2000 lb–18,000 lb.
Contact your nearest Depot :

GEORGE COHEN,

SONS & CO. LTD.
WOOD LANE, LONDON, W.12.
(Shepherds Bush 2070)
And at Stanningley (Nr. Leeds) . Kingsbury (Nr. Tamworth) . Manchester . Glasgow Swansea . Newcastle . Belfast . Sheffield Southampton . Bath

E200 K

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E168 K

AGENCIES

ARE YOU AN AGENT already covering South-East England, and calling on Plumbers' Merchants and Heating Engineers ? Do you understand the business of Plumbers' Brassfounders ? How would you like to immediately add another £1000 per annum to your income ? Then write to us and if you are the man we are looking for, you can have an immediate appointment.—BOX No. E8588, "The Engineer." D

PATENTS

THE PROPRIETOR of British Patent No. 760,161, entitled "IMPROVEMENTS IN FREE PISTON INTERNAL COMBUSTION POWER HAMMER AND PERCUSSION TOOLS," offers same for Licence or otherwise to ensure its practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, Chrysler Building, New York, 17, New York, U.S.A. E8605 H

MACHINERY Etc. WANTED

ONE Good quality second-hand hydraulically-operated CYLINDRICAL GRINDING MACHINE to be of the travelling wheel head type, and to accommodate items with a maximum diameter of 30in. and 144in. between centres.—BOX No. E8482, "The Engineer." F

MODERN SECOND-HAND MASSEY SELF-CONTAINED FRICTION DROP STAMP WANTED, 20 to 40 cwt. capacity.—BOX No. E8616, "The Engineer." F

FOR SALE

STEAM ALTERNATOR SETS

BELLISS & MORCOM LTD./E.C.C. Steam-driven Alternator Set, 120kW, 150 kVA, 400/230 volts, 50 cycles, 3-phase. Vertical "V" valve type Engine, 175/180 h.p. with steam 150 p.s.i.g., exhausting against 5/10 p.s.i.g. B.P. Complete with Switchboard and A.V.R.

BELLISS & MORCOM/BRUSH, Steam-driven Alternator Set, 150kW, 187·5kVA, 400/230 volts, 50 cycles, 3-phase. Compound engine developing 225 h.p. with steam at 180 p.s.i.g. exhausting against 30 p.s.i.g. B.P.

M.E.I., CO., LTD.,
Upper Villiers Street,
Wolverhampton
Tel.: 26354 (4 lines).

E175 O

COMPUTER CONTROLLED PROFILING MACHINES

INSTALLATION AND MAINTENANCE

TWO ENGINEERS

are required for work on the installation and subsequent servicing of tape controlled automatic profiling machines. Candidates should have the H.N.C. or equivalent qualification in Electrical Engineering and have experience of electro-mechanical and electronic devices and control systems. Experience of servicing light current electrical installations may be an advantage.

A period of training will be given prior to the machine installations, and for the first twelve months thereafter, one engineer will be resident on the N.E. Coast and one in the N.W. Lancashire Area.

Applicants who should be at least 30 years of age, will be offered a good commencing salary and they should be earning not less than £1000 per annum in their present employment. A contributory pension scheme is in operation.

Please reply stating full particulars to the :

Personnel Manager, British Oxygen Gases, Ltd.,
Spencer House, St. James's Place, S.W.1.

E8624 A

PROJECT ENGINEER

Applications are invited for suitably qualified persons for appointment as Project Engineer in an expanding Division of an old-established Company in Yorkshire.

The work is concerned with controlled atmosphere generators and gas drying equipment, and the project engineer would be responsible for the design, installation and subsequent testing of new plant, and the work would involve some time spent on site.

Candidates should have a technical qualification in Chemical or Mechanical Engineering or Fuel Technology, preferably to degree standard.

Superannuation scheme and other benefits.

Salary by arrangement.

Please send brief details in confidence to Manager, Gas Handling Divis on, W. C. Holmes & Co., Ltd., Turnbridge, Huddersfield.

E8436 A

YORKSHIRE IMPERIAL

MECHANICAL ENGINEERS

YORKSHIRE IMPERIAL METALS, LIMITED,

is the largest manufacturer of copper and copper alloy tubes and fittings in Europe and compares favourably, both in size and equipment, with the largest producers in the U.S.A. Further and extensive modernisation of the manufacturing facilities is contemplated, together with research and development work on new methods of tube and product manufacture.

Mechanical Engineers of high calibre are required for design and maintenance duties. Preference will be given to candidates with high professional qualifications and appropriate experience, but due regard will be paid to potential abilities and personal qualities which will assist in collaboration with other members of the Staff.

The appointments will, in the first instance, be at the Works in Leeds, but there are also factories at Birmingham, Liverpool, Glasgow, Dundee and Swansea, where new appointments may be made in the future. Salaries offered to successful applicants will be commensurate with qualifications and experience.

The Company operates a Pension and Life Assurance Scheme, Profit-Sharing Scheme, and has excellent welfare facilities. Consideration would be given to candidates requiring assistance when removing home.

Applications, giving full details of age, qualifications, experience and present salary, should be marked "Engineer" and addressed to :—

The Chief Personnel Officer,
Yorkshire Imperial Metals, Ltd.,
P.O. Box 166,
Leeds.

E8506 A

AUSTRALIANS AUSTRALIANS AUSTRALIANS

With an Engineering Degree and practical experience in engineering production and factory management are invited to apply for a position of MANAGING DIRECTOR of a well-established and profitable engineering manufacturing company with a modern factory in Sydney.

The company is a wholly-owned subsidiary of a powerful Group with headquarters in Britain and world-wide connections. Full responsibility for the operation of the Australian subsidiary is vested in the Managing Director who has a local Board of Directors. The appointment carries a high basic salary with additional bonus calculated on profits and the use of a Company car, superannuation, and other benefits.

This is a splendid opportunity for an Australian with the qualities of management, initiative, and leadership, the qualifications of an engineer, and the experience of factory production, to secure a remunerative and responsible position in his own country.—Applications to BOX No. E8513, "The Engineer."

A

CHIEF METHODS ENGINEER

for a progressive, medium-sized Company of medium/heavy engineers with headquarters in the Manchester area. Initial salary from £1500 p.a., plus pension scheme, considerable fringe benefits and prospects of advancement. Preferred age 30–40.

The Chief Methods Engineer will be responsible to the Works Manager for process planning, time standards and rate-fixing and will also be in charge of the jig and tool design office, the tool-room and the tool store employing in all about 70.

Qualifications required are sound experience of process planning, time-standards and rate-fixing as they apply to small-batch work in a concern of the type indicated, plus the ability to control a jig and tool design office and a tool-room.

Should also have sound knowledge of cost control, stock control, buying and stores procedures, plus the ability to work in close contact with all levels of management.

Please write briefly in first instance, quoting Reference No. 323, to :—

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

E8573

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.
Fielding 200-ton ditto, 3ft. stroke, with pumps and motors (5 available).
Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.
Two 73ft. 4in. by 4ft. Brick Lined Kilns or Dryers, with Crofts reduction gears and motors.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.

FRED WATKINS (ENGINEERING), LTD., COLEFORD, GLOS. E151 G

HAVE YOU A STOCKPILE HANDLING PROBLEM? A self-loading, self-discharging rotary disc loader is immediately available. Capacity between 70 tons per hour for coke and 200 tons per hour for ore. Electric drive from 400/440 volts, 3-phase, 50 cycle supply. Caterpillar tracks. Discharge conveyor slews through 180 degrees. One-man operated. For further information, telephone SIMONSWOOD 3361, or write, Lt.-Col. B. M. Butler, Search (Liverpool) Limited, Hammond Road, Kirkby Trading Estate, Liverpool. E8551 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent. (Tel.: Bexleyheath 305). E113 G

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone: Knottingley 2743/4). E116 MW

MACHINE CAPACITY REQUIRED.—A large firm in the Havant area invites enquiries from various small sub-contractors within easy operating area of the district who can offer the following facilities:
Light press work up to 40 tons;
2nd Op. Press work up to 10 tons;
Drilling, Countersinking and Tapping Capacity;
Capstan Capacity;
Production Milling Capacity.
BOX No. E8559, "The Engineer." MW

WELL-KNOWN COMPANY'S SOUTHERN SERVICE WORKS ideally situated in N.W. precincts of London whilst mainly engaged in heavy engineering and mechanical handling equipment, has capacity available for assembly and supply of component parts, &c.—Write BOX No. E2688, "The Engineer." MW

FOR SALE

TWW

AIR COMPRESSORS

C.F.M.	Make	Lbs. p.s.i.	Type	H.P.
300	Broomwade	100	EH.241	75
270	Broomwade	100	EH.240	55
210	C.P.T.	100	PB-4-210	50
200	Belliss & Morcom	100	—	49
200	Broomwade	100	D.23	45
100	Reavell	100	DSA6E	25

THOS. W. WARD LTD.

ALBION WORKS - - - SHEFFIELD
'Phone: 26311. 'Grams: "Forward."
E215 G

FOR SALE

4-ton Jones KL44 MOBILE CRANE, Ruston diesel, on pneumatics.
5-ton Morris Versatile Diesel/Elec. MOBILE CRANE on solids.
¾ cu. yd. Rapier 410 Diesel-driven EXCAVATOR with 4-purpose equipment.
167 c.f.m. BroomWade Portable Diesel-driven COMPRESSOR on pneumatics.

WILLIAM G. SEARCH LIMITED,
WHITEHALL ROAD, LEEDS, 12.
Tel.: 639081 (10 lines).
SEARCH (LIVERPOOL) LIMITED,
HAMMOND ROAD,
KIRKBY TRADING ESTATE, LIVERPOOL.
Tel.: Simonswood 3361 (5 lines).
E8569 G

CINCINNATI 12IN. BY 48IN. HYDRAULIC UNIVERSAL GRINDER
Filmatic spindle bearings. Grinding wheel 14in. by 1½in. With internal attachment and various chucks, steadies, &c., M.D.400/3/50.

H. BELL (MACHINE TOOLS), LTD.,
WALTER STREET, LEEDS, 4.
Tel.: 63-7398.
E105 G

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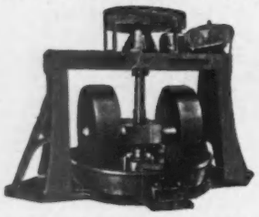

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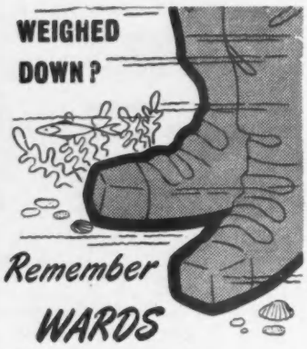

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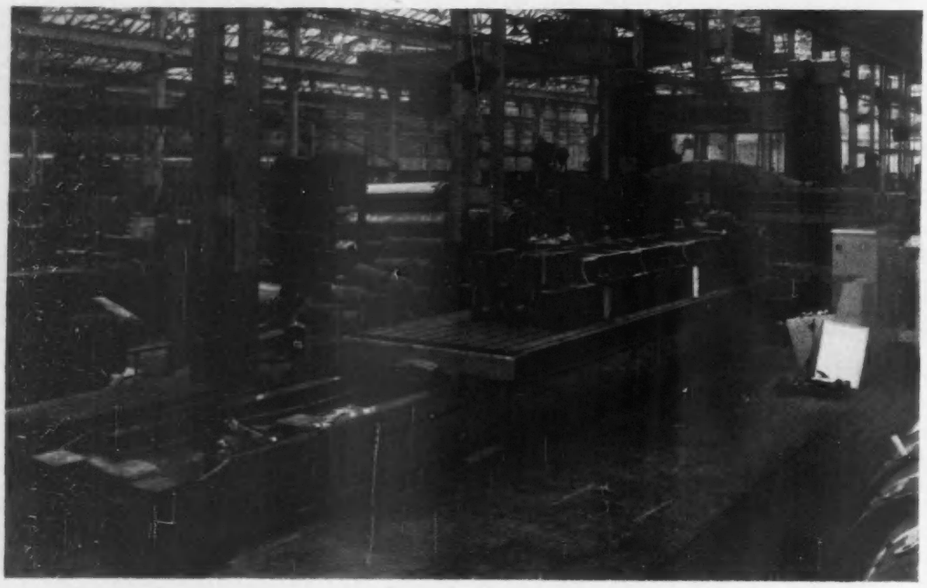

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		Main Location	*Auctioneers*
February 2	**Miscellaneous stores,** including :— universal rigid lap machine ; single action power press ; spot welders ; annealing, cutting, trimming and tapering machines ; saw bench ; draw presses ; gravity roller conveyor straights ; types ; tubes ; petrol and water cans ; seats and cushions ; accumulators ; towing ropes ; hydraulic and screw jacks ; fire extinguishers ; tyre pumps and inflators ; carburettors ; generators and other M.T. spares ; leather tool bags ; auxiliary charging sets ; storehouse trucks ; hand stackers ; fire pumps ; folding tables ; chairs ; cupboards and cabinets ; refrigerators ; webbing ; canvas canopies ; Kraft, creped and waterproof paper ; hessian wrappers ; paper packed hessian ; twine ; rope ; cordage ; khaki drill skirts ; motor cyclists boots ; rubber thigh boots ; textiles ; clothing ; footwear, etc.	M.O.A. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
February 10	**Machine tools, woodworking machinery, arc welders and transformers, etc.**	Technical Stores Depot, **Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
February 18	**Miscellaneous stores.**	M.O.A. Storage Depot, **Rotherwas, Hereford.**	**RUSSELL, BALDWIN & BRIGHT, LTD.** (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
February 25	**Vehicles and miscellaneous stores.**	M.O.A. Storage Depot, **Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.**	**DIXON & WALLACE, LTD.** (Dept. L), Bank Buildings, Graham Street, Glasgow, E.1. (Tel.: Bridgeton 2447/9.)
March 1-2	**Machine tools and miscellaneous stores.**	M.O.A. Storage Depot, **Byley, Nr. Middlewich, Cheshire.** (Sale at Cheetham Town Hall, Manchester, 8.)	**J. H. NORRIS & SON** (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)

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E118 J

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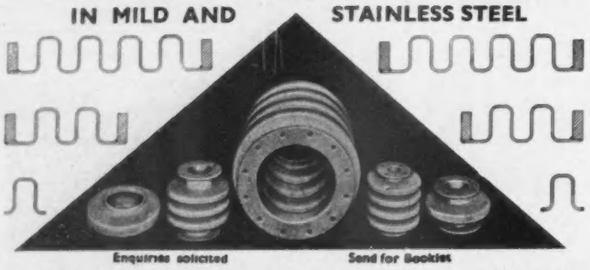

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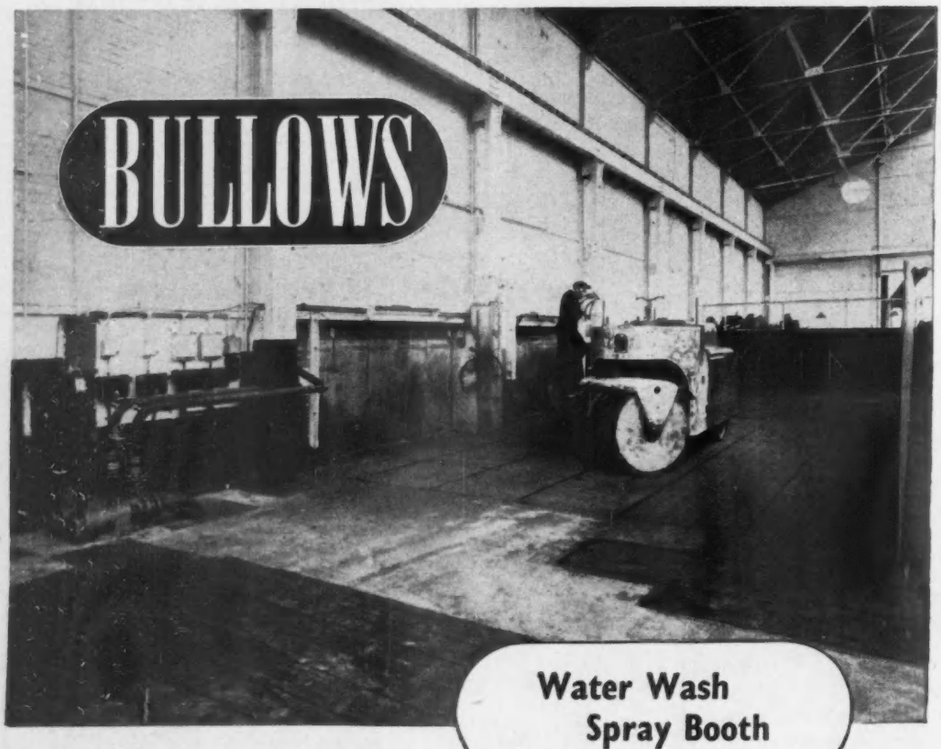

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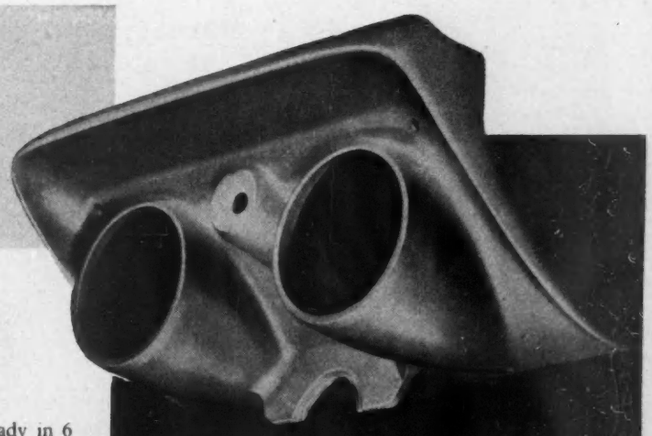

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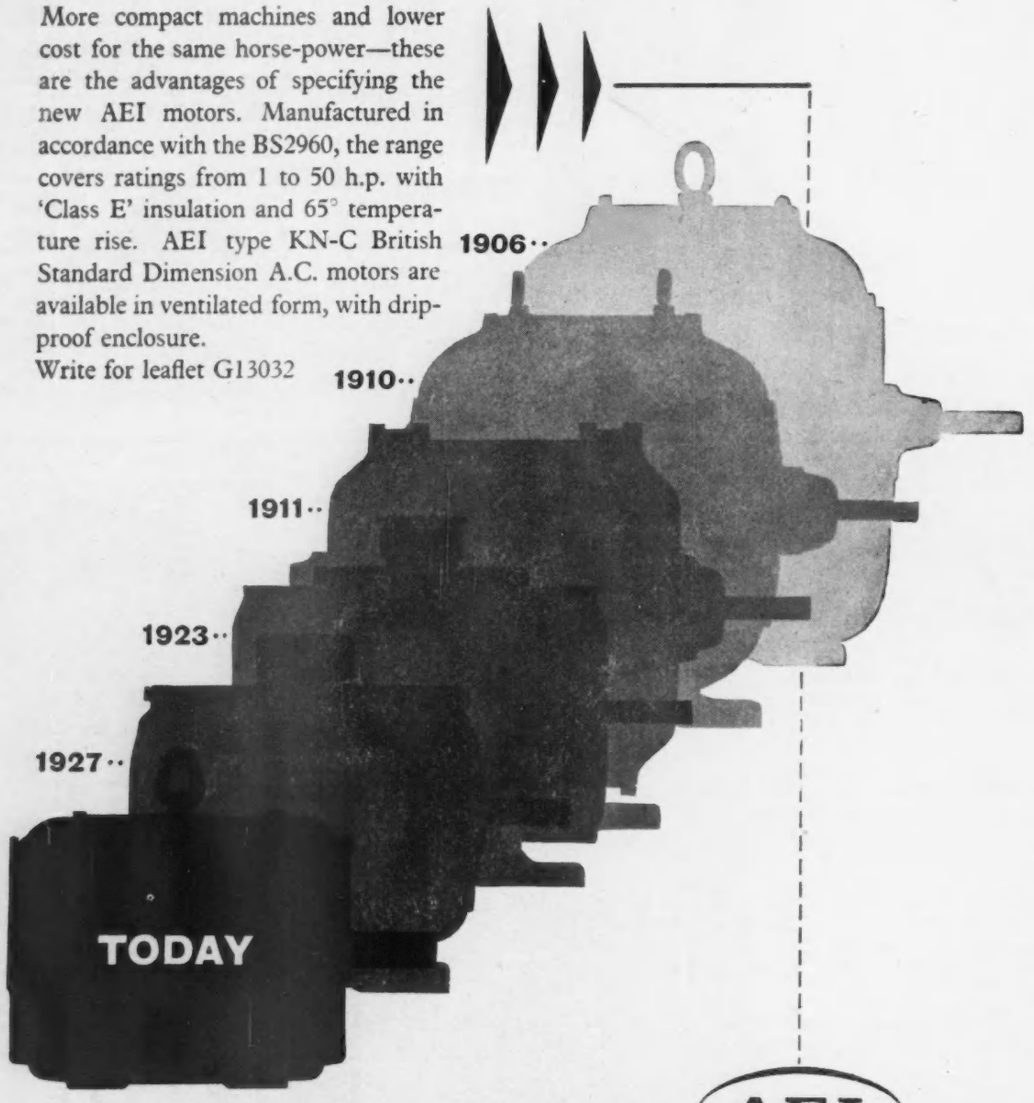

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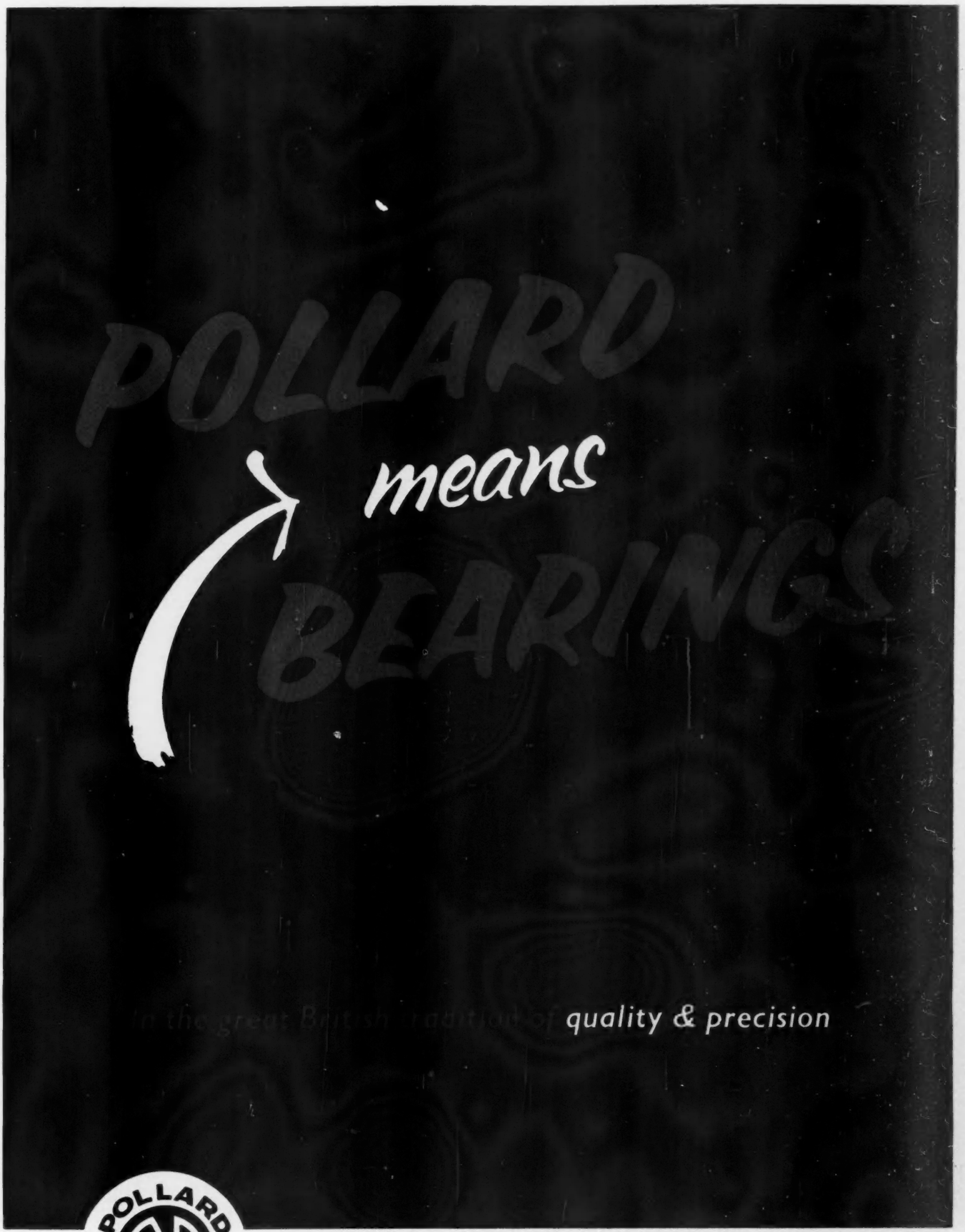

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